INSTRUCTION MANUAL

UV-160A
UV-VIS
RECORDING SPECTROPHOTOMETER

(P/N 204-04550)

SHIMADZU

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UV-VIS
RECORDING SPECTROPHOTOMETER

(P/N 204-04550)

SHIMADZU CORPORATION
SPECTROPHOTOMETRIC INSTRUMENTS PLANT
ANALYTICAL INSTRUMENTS DIVISION
KYOTO, JAPAN

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Introduction

Thank you very much for purchasing the Shimadzu UV-VIS Spectrophotometer UV-160A. The UV-160A is a micro-computer-controlled double-beam recording spectrophotometer which has the following features:

1. This very compact instrument combines a monochromator, keyboard, CRT, and graphic printer.
2. It has only 24 single-function keys which permit easy operation.
3. It permits scanning speeds up to 2400nm/min, thus greatly reducing measuring time.
4. It incorporates many standard calculation programs such as data determination at a fixed wavelength, automatic quantitative analysis by two/three-wavelength calculation or derivative values, kinetic measurement, and multi-component analysis.
5. It permits various spectral processings such as the expansion/compression of spectra, peak-pick, derivative, smoothing, data storage, and arithmetic calculation between spectra.

Additionally, the availability of several accessory attachments enhances the UV-160A for routine and research analyses in various fields.

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Chapter 1 Installation

1. Installation

When unpacking, be sure to read this chapter before turning on the power switch.

1.1 Inspection of Parts

When unpacking, confirm that the following parts are all contained:

Table 1.1 Standard Contents

No.	Description	Qt.	Part No.
1	Spectrophotometer	1	204-04551-01
2	Thermo-sensitive chart	1 roll	200-91532-02
3	Chart axle	1	204-06895
4	Spare fuse	2	072-01027 (5A, for 100/117V line) or 072-01005 (3A, for 200/240V line)
5	Vinyl cover	1	204-08083
6	Power cable with plug	1	200-81008-01 (for 100/117V line) or 200-81008-02 (for 200/240V line)
7	Instruction manual	1	CME101-025
8	Operation sheet	1	CME101-026

1.2 Installation

Install the instrument in a location that satisfies the following requirements:

(1) Avoid a dusty place.

(2) Avoid a place with corrosive gases such as chlorine gas, hydrogen chloride gas, hydrogen sulfide gas, sulfur dioxide, fluorine gas, and ammonia gas.

(3) Avoid a place with high temperature or high humidity. Room temperatures of 15°C to 35°C with humidities of 45% to 80% are recommended, with less than 70% humidity for temperatures greater than 30°C.

(4) Avoid a place with strong or continuous vibrations.

(5) Avoid a place exposed to direct sunshine.

(6) Separate the instrument as much as possible from units that generate magnetic fields, electric fields, or high-frequency waves.

(7) This instrument requires a space of 65cm width, 60cm depth, and 50cm height. Its rear side should be separated by more than 10cm from the room walls. Especially, don't place any objects near the fan. This could result in obstruction of air flow.

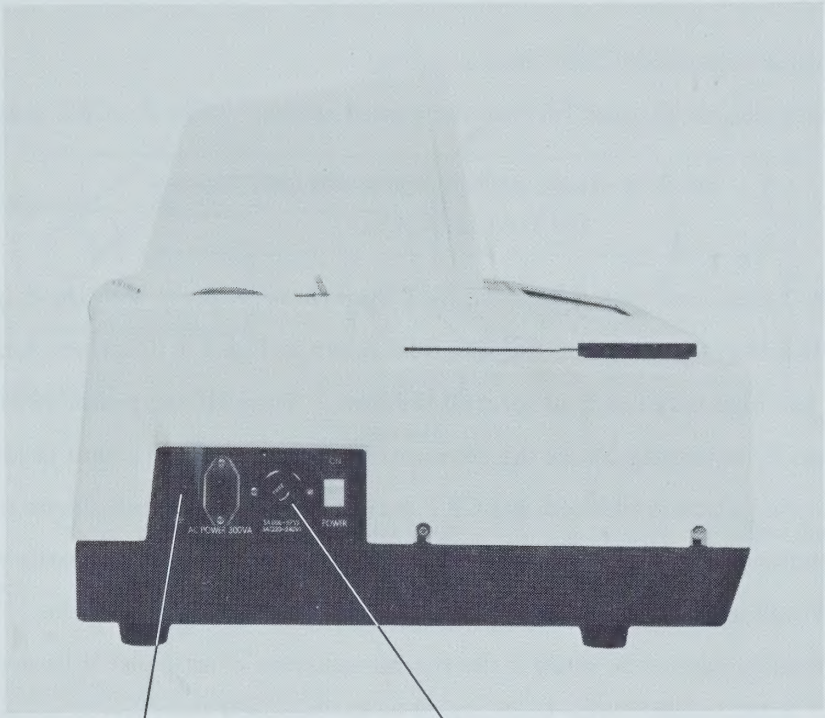
(8) Place this instrument on a strong and stable table capable of withstanding a load of 42kg

with equal leg load distribution.

As shown in Fig. 1.1, there is a line voltage selector in the rear position on the left side. It can be set to 110V, 117V, 220V or 240V according to the line voltage used. To change the setting, first pull out the fuse holder with a regular screw-driver or coin, and then remove the round-type plug which reads VOLTAGE SELECTOR. Re-insert the plug in a new position, and restore the fuse holder. Additionally, the power frequencies of 50Hz and 60Hz are commonly used. Fuses of 3A and 5A are used for 220/240V and 100/117V respectively.

For line voltages other than 100V, 117V(115V), 220V and 240V, (such as 110V, 120V and 230V), use a step-down power transformer (accessory part number 200-45100 to step-down from 230 to 100V, part number 200-82005 to step-down from 110 or 120 to 100V).

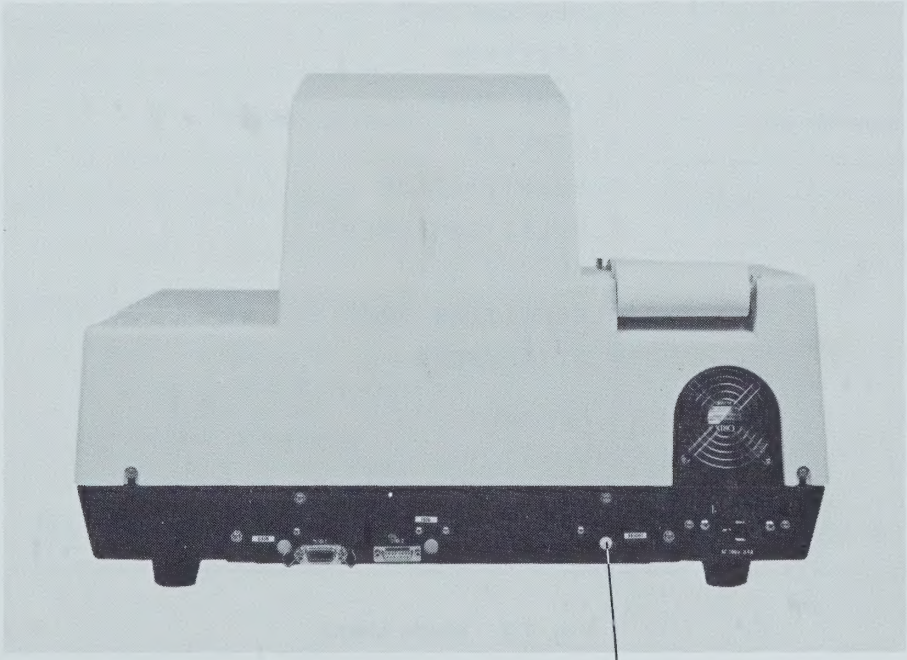
Be sure to confirm that the power switch is turned off before plugging the power cable of the instrument into a power outlet. Additionally, the power line should contain a ground line. If there is no ground line, use the grounding terminal (in Fig. 1.1).



Grounding terminal

Line voltage selector and fuse holder

Left side



Brightness control knob

Rear side

Fig. 1.1 Left Side and Rear Side of the Instrument Main Body

1.3 CRT Brightness Adjustment and Chart Loading

After finishing the installation, turn on the power switch. Then the CRT indicates:

```
*** UV-160A SPECTROPHOTOMETER ***
INITIALIZATION
```

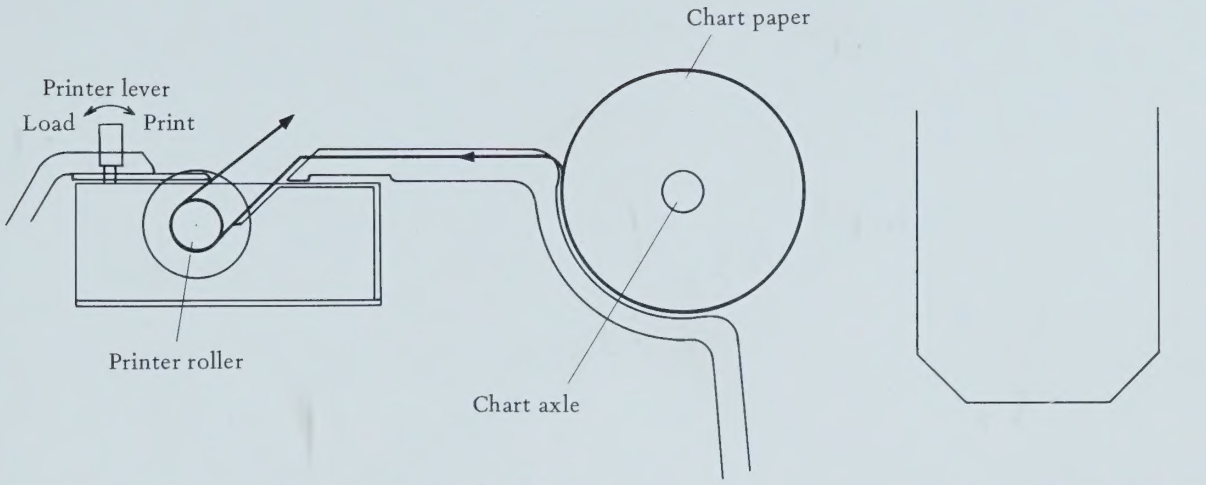
Wait for nearly 3 min., and then adjust the CRT brightness properly with the brightness control knob located in a lower position on the rear side shown in Fig. 1.1 (Caution: Adjusting the brightness intensity too high may result in spectral shadows. Turn off the power switch after more than 10 seconds from turning on, or the center of CRT may result in a spot shadow).

When the initialization is finished, the CRT indicates the mode menu shown in Fig. 1.2. Load the thermo-sensitive chart paper after pulling the printer lever forward towards you as shown in Fig. 1.3(a). Loading the paper can easily be accomplished while pressing the [CHART FEED] key. Proper chart feeding cannot be made if the thermo-sensitive chart paper is loaded obliquely to the printer roller. Additionally, chart loading will be facilitated if the chart is cut with scissors in a shape shown in Fig. 1.3(b). After the chart paper loading, throw the printer lever to the rear position, away from you.

```
MODE No.="1"?
1.PHOTOMETRIC
2.SPECTRUM
3.TIME SCAN
4.KINETIC
5.QUANTITATIVE
6.MULTI-COMPONENT
7.MEMORY OUT
8.CONDITION SET
9.ATTACHMENT

9:05 10/05 '84                    800.0NM   0.000A
```

Fig. 1.2 Mode Menu



(a) Printer and Related Parts

(b) Cutting of the Chart Paper

Fig. 1.3 Thermo-Sensitive Chart Paper Loading

1.4 Performance Check at Installation

After finishing the installation, check each of the following items. If any of them are faulty due to mechanical shock during transportation or other causes, contact our nearest service office. Operate the instrument according to the following procedure 30 min. after turning on the power switch.

1.4.1 Baseline Flatness

Operating procedure:

Step	Operation & display	Key operation	Next step
1	Select mode No. 2 "Spectrum Mode"	MODE 2 ENTER	
2	SPECTRUM PARAMETER CHANGE Y/N ? 1.λS= 800.0NM λE= 400.0NM 2.MEASURE(ABS/T%)=ABS 3.UPPER=+2.00A LOWER=+0.00A 4.SCAN SPEED=FAST 5.CYCLE T= 60SEC N= 1 6.OVERLAY NO 7.COPY NO 8.SURVEY SCAN NO 9.FILE		
3	Set the wavelength range to "1100~200" nm	YES 1 ENTER 1100 ENTER 200 ENTER	

Step	Operation & display	Key operation	Next step
4	Select mode No. 8 "Condition Setting"	MODE 8 ENTER	
5	PARAMETER No.="1"? 1.BASELINE 2.CLOCK SET 3.CLOCK DISPLAY 4.LAMP CHANGE λ 5.LAMP SELECT 6.FILE DELETE		
6	Baseline correction	1 ENTER	
7	* * * BASELINE CORRECTION * * *		
8	Wait for baseline correction to be completed (approx. 75 sec.)		
9	Select mode No. 2 "Spectrum Mode"	MODE 2 ENTER	
10	PARAMETER CHANGE Y/N ?		
11	Set the photometric range to "0.01~-0.01" ABS and scanning speed to "SLOW"	YES 3 ENTER 0.01 ENTER -0.01 ENTER YES 4 ENTER 3 ENTER NO	
12	SET SAMPLE, PRESS START KEY		
13	Start the scan with AIR in REF and AIR in SAMPLE	START/STOP	
14	DATA PROCESSING Y/N ?		
15	If the data processing is unnecessary	NO	
16	Confirm that the result of the baseline flatness satisfies the specification shown below. The next measurement can be started by pressing the START/STOP key. When the RETURN key is pressed, the instrument returns to Step (10). Then, when the MODE key is pressed, the CRT indicates the mode menu.		

Specification:

The baseline flatness exclusive of shock noise should be within ±0.002 ABS.

Example of measurement:

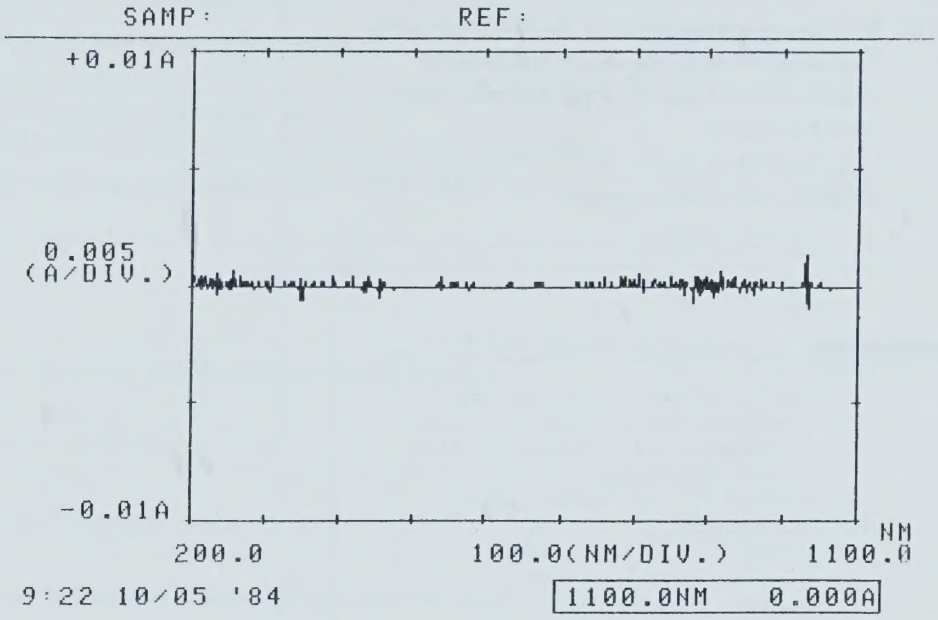


Fig. 1.4 Example of a Measurement for Baseline Flatness

1.4.2 Wavelength Accuracy

Operating procedure:

Step	Operation & display	Key operation	Next step
1	Select mode No. 0 "Check Mode" When the instrument in not in the basic mode menu display, select the parameter changing display by pressing [RETURN] key. Then, select mode No. 0 "Check Mode". * This mode is used only for checking the instrument; not for usual measurements. Therefore, any detailed descriptions are made nowhere in this manual except here.	[RETURN] [MODE] [0] [ENTER]	
2	OPERATION No.="1"? 1.ROM CHECK ..... *1 2.BL.CLEAR ..... *2 3.S.BEAM W,D2 ..... *3 4.S.BEAM W ..... *4 5.S.BEAM D2 ..... *5 6.S.BEAM LAMP OFF ..... *6 7.ZERO ORDER LIGHT *7		

*1~*7: Refer to page 1-9.

Step	Operation & CRT display	Key operation	Next step
3	Select the single beam D_2 (deuterium lamp) NOTE: With the energy spectrum of the deuterium lamp (including the monochromator and detector characteristics) being $E(\lambda)$, the following value can be measured: $C_1 \log E(\lambda) + C_2$ where C_1 and C_2 are constants.	5 ENTER	
4	SPECTRUM PARAMETER CHANGE Y/N ? 1.λS=1100.0NM λE= 200.0NM 2.MEASURE(ABS/T%)=ABS 3.UPPER=+0.01A LOWER=-0.01A 4.SCAN SPEED=SLOW 5.CYCLE T= 60SEC N= 1 6.OVERLAY NO 7.COPY NO 8.SURVEY SCAN NO 9.FILE		
5	Set the measuring wavelength range to "660 ~ 650"nm and the photometric range to "0.6 ~ (−0.1)" ABS	YES 1 ENTER 660 ENTER 650 ENTER YES 3 ENTER 0.6 ENTER −0.1 ENTER NO	
6	SET SAMPLE, PRESS START KEY		
7	Start the scan with AIR in REF and AIR in SAMPLE	START/STOP	
8	DATA PROCESSING Y/N ?		
9	Data processing is necessary	YES	
10	1)SAVE 2)EXP. 3)PEAK 4)DERIV. 5)PRINT 6)PLOT No.=		
11	Select the "Peak-pick" mode	3 ENTER	

Step	Operation & CRT display	Key operation	Next step
12	Compare the indicated peak wavelength with 656.1nm(see Fig.1.5)		
13	Return to the parameter setting display	RETURN	
14	PARAMETER CHANGE Y/N ?		
15	Set the measuring wavelength range to "490 ~ 480" nm	YES 1 ENTER 490 ENTER 480 ENTER	
16	Start the scan with AIR in REF and AIR in SAMPLE	NO START/STOP	
17	DATA PROCESSING Y/N ?		
18	Select the "Peak-pick" mode	YES 3 ENTER	
19	Compare the indicated peak wavelength with 486.0nm(see Fig.1.5)		
20	End. Another check can be made by pressing the START/STOP key. When the RETURN key is pressed, the instrument is returned to Step (14). Then, when the MODE key is pressed, the CRT indicates the basic mode menu.		

*1 Used to check READ ONLY MEMORY circuitry.

*2 BASELINE CLEAR function. Used to clear baseline memory.

*3 SINGLE BEAM MODE utilizing both the tungsten lamp (W) and the deuterium lamp (D_2) for excitation. This function permits lamp energy investigation in either the visible (W lamp) or ultra-violet (D_2 lamp) portion of the electromagnetic spectrum.

*4 SINGLE BEAM MODE utilizing just the tungsten lamp for excitation. This function permits W lamp energy investigation.

*5 SINGLE BEAM MODE utilizing just the deuterium lamp for excitation. This function permits D_2 lamp energy and wavelength accuracy investigation.

*6 SINGLE BEAM MODE with both tungsten (W) and deuterium (D_2) lamps turned off. This mode is selected when a mercury lamp (Hg) is used to check wavelength accuracy.

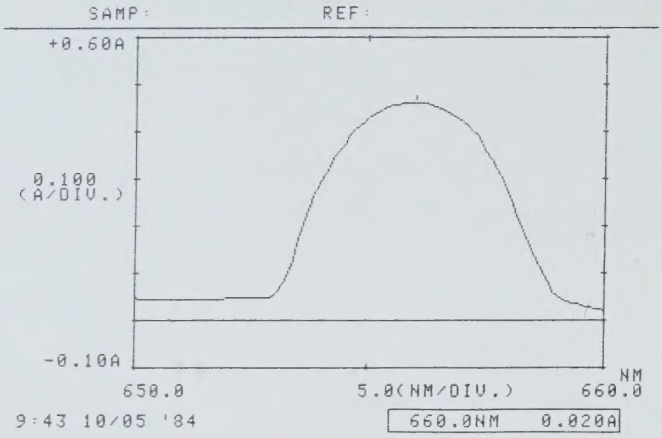
*7 ZERO ORDER LIGHT function. This function positions the grating such that "white light" is allowed to enter the sample compartment. Permits ease of beam alignment when the optical alignment is to be made.

NOTE: The 7 functions above are used by authorized Shimadzu Service personnel as diagnostic aids in determining the source of a problem should one occur, please contact your local Shimadzu Service Center for servicing assistance.

Specification:

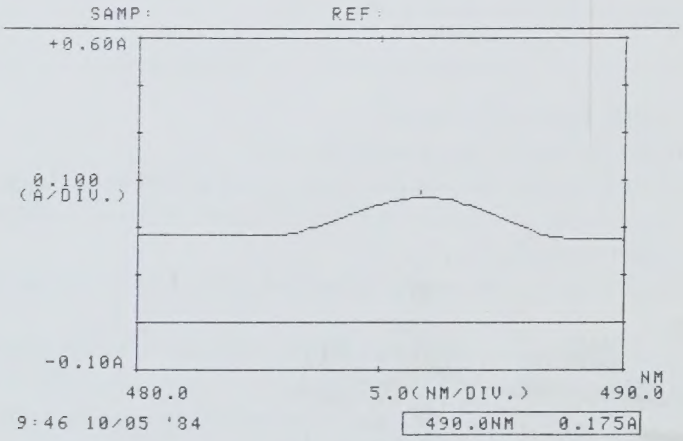
The wavelength accuracy should be within ± 0.5nm (around 656.1nm and 486nm).

Examples of measurement:



*** PEAK-PICK ***

-- PEAK --		-- VALLEY --	
λ	ABS	λ	ABS
656.0	0.461		



*** PEAK-PICK ***

-- PEAK --		-- VALLEY --	
λ	ABS	λ	ABS
485.8	0.264		

Fig. 1.5 Examples of Measurements for Wavelength Accuracy

Chapter 2 Specifications

2. Specifications

Measuring wavelength range	200 ~ 1100nm
Spectral band width (resolution)	2nm
Wavelength readability (wavelength setting)	0.1nm increment
Wavelength accuracy	±0.5nm, with automatic wavelength correction
Wavelength reproducibility	±0.1nm, when being set from the longer wavelength side
Wavelength scanning speed	Monochromator setting speed is nearly 3600nm/min. FAST ..... Nearly 2400nm/min. M ..... Nearly 1500nm/min. SLOW ..... Nearly 480nm/min. } at sampling intervals of 1nm (SURVEY SCAN)
Sampling interval	Automatic setting according to wavelength ranges: 900nm ≧ λ range > 500nm 1nm 500nm ≧ λ range > 200nm 0.5nm 200nm ≧ λ range > 100nm 0.2nm 100nm ≧ λ range ≧ 10nm 0.1nm
Light source switching	Automatic switching according to wavelengths. Any light source can be selected between 295 and 364nm.
Stray light	Less than 0.1% at 340nm with UV-39 filter Less than 0.1% at 220nm with NaI solution, 10g/ℓ
Photometric system	Double-beam system
Photometric range	Absorbance: -2.0 ~ 2.0 ABS (after baseline correction and when non corrected baseline flatness is within ± 0.5 ABS) Transmittance: 1 ~ 125%T
Recording range	Absorbance: -2.5 ~ 2.5 ABS Transmittance: -125 ~ 125%T
Photometric accuracy	±0.005 ABS at 1.0 ABS with NBS930 standard filter
Photometric reproducibility	±0.002 ABS at 1.0 ABS
Response	0.02 sec. in "Spectrum" Mode 0.1 sec. in "Time Scan" Mode } Changes according to the optical energy and measuring conditions. (The response time becomes longer for less optical energy. When the spectrum has high and varying absorbances, the scanning speed should be reduced.)
Auto Zero function	One-touch setting with [AUTO ZERO] key
Drift	Within 0.001 ABS/hr (2 hrs. after turning on)

Baseline correction	Automatic correction with computer memory (after turning on the power). Recorrection is possible.
Baseline flatness	±0.002 ABS (excluding noises)
Recording mode	① Print-out of measured data and calculated results ② Drawing of spectra and other curves with printout of parameters and data
Repeated scan	Cycling time of 0 ~ 9999 sec., selectable Repetition number of 1 ~ 99, selectable
Wavelength program	Up to 5 wavelengths, 0.1nm increment Repetition number of 1 ~ 99, and cycling time of 0 ~ 9999 sec.
Spectrum processing	① Data memory, with two channels for overlapping, subtraction and division between channels ② Expansion and compression ③ Peak detection ④ Differentiation (for derivative) or smoothing ⑤ Data output at regular intervals of wavelength or time
Kinetics (Enzyme Rate Assay)	Absorbance changes are measured at regular intervals of time, while the reaction curve is displayed on CRT. Then, the absorbance change rate (ABS/min.) during the Rate period is obtained by the least-squares method using up to 20 points. The activity value which is the absorbance change rate multiplied by the FACTOR is output. The activity value for another Rate measuring period (within the original reaction duration) can be obtained after measurement.
Quantitative determination program	① Automatic determination using one wavelength. Determination with two/three wavelength value or 1st ~ 4th order derivative value. ② Automatic determination of concentration with linear regression working curve (up to 20 points). ③ Automatic determination of concentration with polygonal regression working curve (up to 20 points). ④ Setting of up to 20 standard sample concentration via keyboard. Selectable setting or measuring of absorbance values. ⑤ Determination with repeated measurements (1 to 9 times) and their avarage.
Time scan	Time-course recording within 10~6000 sec. After measurement, data processings are possible such as data storage, expansion/compression, peak detection, differentiation, smoothing and data output at regular time intervals. NOTE: A Digital to Analog accessory (P/N 204-04757) is available for HPLC data purposes.
Multi-component determination	Mixed samples of up to eight components can be determined. Mixed samples can be used as standards. Standard sample data can be stored in the back-up memory (up to 16 standards).

Back-up memory	20 sets of either analytical conditions, working curves, matrix for multi-component determination and clock
Date indication	Indication of date and time with clock
Light source	50W long-life halogen lamp (2000 hrs.), and socket type deuterium lamp (500 hrs.) with automatic control of maximum sensitivity
Monochromator	Aberration-corrected concave holographic grating with f = 4.2
Detector	Silicon photo-diode, 2 pcs. (matched pair)
Recorder	Computer-controlled thermal graphic printer
Chart paper	Thermo-sensitive chart paper of effective width of 110mm (280 dots), roll type, 50m long
CRT	9-inch with graphic function, 240 X 320 dots
Sample compartment	Inner size: 110mm wide, 230mm deep and 105mm high Optical path length of cell: Up to 100mm Cartridge type, easily removable/mountable Distance between sample and reference beams: 100mm 10mm rectangular cell holder on each of sample and reference sides
Power requirements	With line voltage selector for 100, 115, 220 and 240V
Size	630mm wide, 500mm deep and 450mm high
Weight	42kg
Ambient atmosphere	Room temperature 15 ~ 35°C with humidities of 45 ~ 80%, with less than 70% humidity for more than 30°C.
Operating accessory software	*Contains operating software for the following uses: 1) sipper operation, 2) external analog spectrum recording, 3) external analog time scan recording, 4) data print function for cell positioner, 5) cell positioner kinetic measurements.

*For complete operation, the following respective accessories are required:

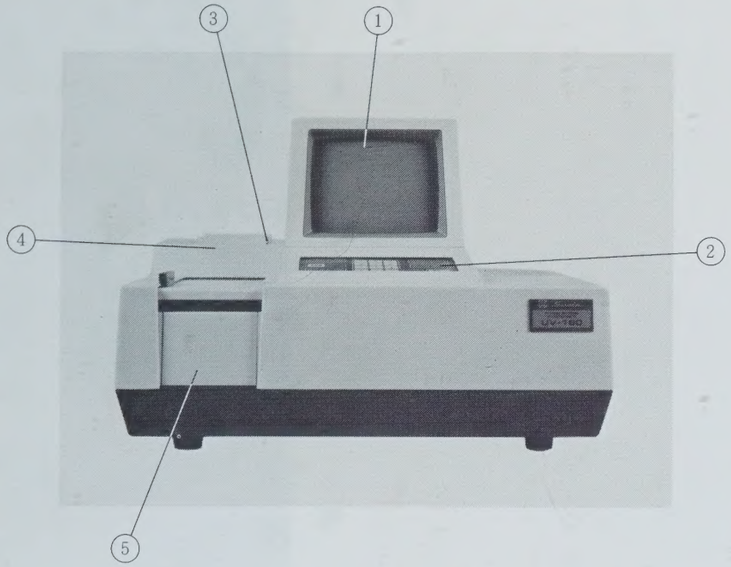
1) sipper 160 (P/N 204-08270-01~-03)
2) analog output interface (P/N 204-04757)
3) analog output interface (P/N 204-04757)
4) cell positioner CPS-240A (P/N 204-05837-01)
5) cell positioner CPS-240A

Chapter 3 Construction

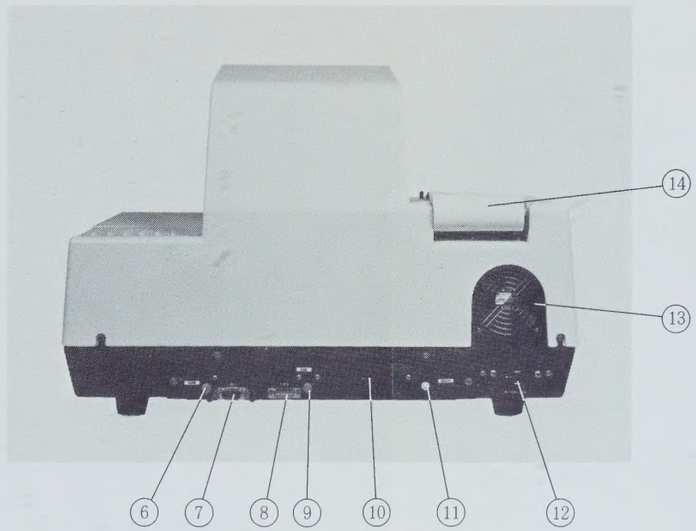
3. Construction

3.1 Outside View

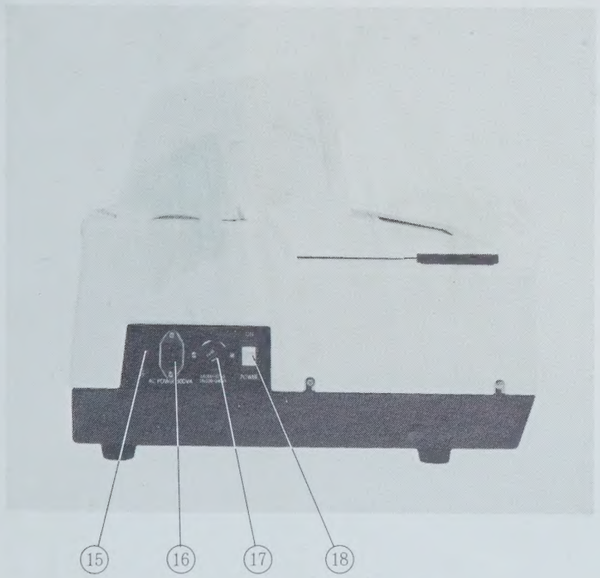
Fig. 3.1 shows an outside view of this spectrophotometer.



Front side



Rear side



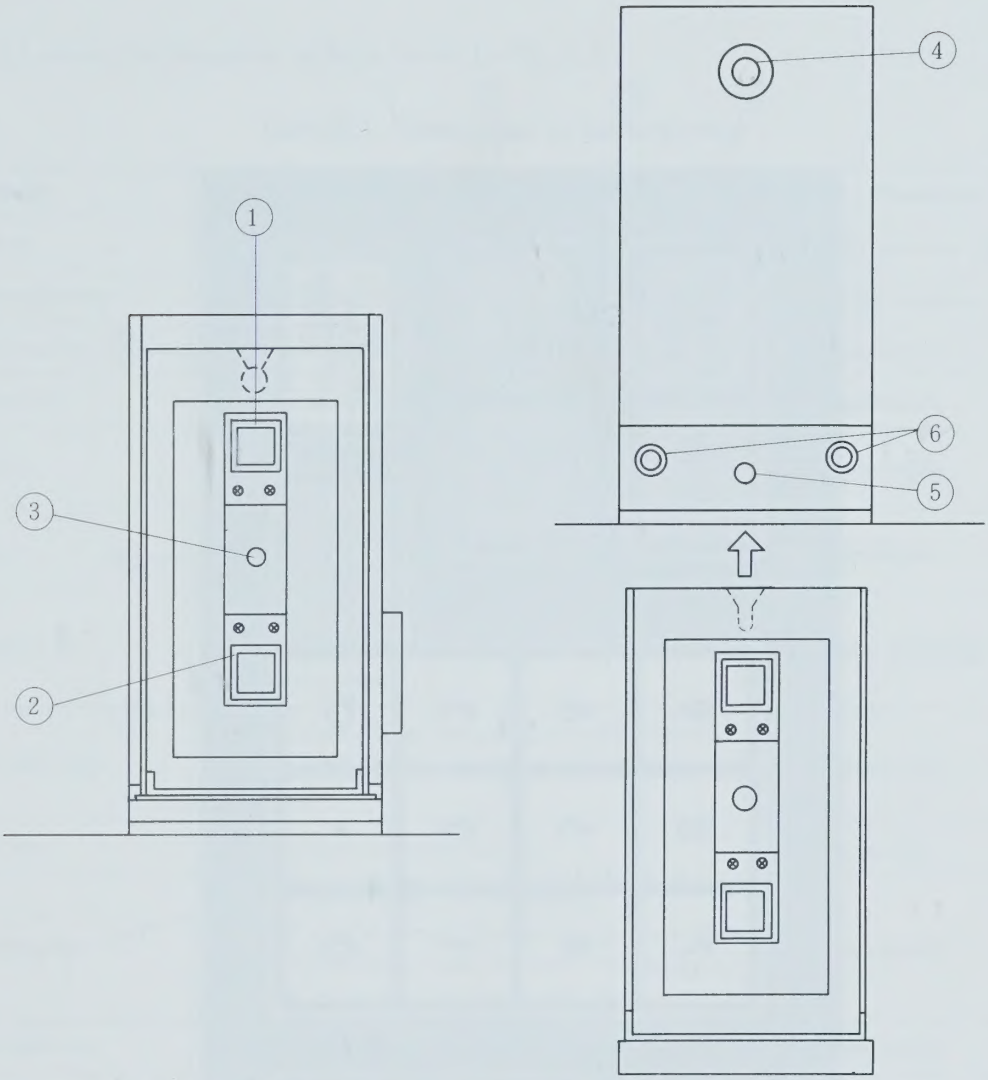
Left side

Right side

Fig. 3.1 Outside View of the UV-160A

	Name	Description
①	CRT	9-inch size, 240 X 320 dots
②	Keyboard	with 24 sheet keys
③	Printer lever	Used to load the chart
④	Printer	Thermal graphic printer
⑤	Sample compartment	110mm wide, 230mm deep and 105mm high
⑥	GAIN	Trimmer for adjusting the photometric sensitivity. It has been factory-adjusted and should not be touched.
⑦	I/O 1	Connector for the auto sample changer or cell positioner
⑧	I/O 2	Connector for the Sipper 160
⑨	FEED	Trimmer for adjusting the chart feed. It has been factory-adjusted and should not be touched.
⑩	Cover for option	Used to cover the hole for attaching Analog Output Interface, GP-IB Computer Interface or RS-232C Computer Interface.
⑪	Brightness control	Used to adjust the CRT brightness
⑫	AC power outlet	Used for an attachment (refer to item 4.11)
⑬	Fan	
⑭	Printer chart	Effective width of 110mm (280 dots)
⑮	Grounding terminal	Used for grounding the spectrophotometer
⑯	AC power cable	
⑰	Line voltage selector and fuse holder	Used to select one of four line voltages, AC100V, 115(117)V, 220V and 240V. 5A fuse is used for 100 ~ 117V, and 3A fuse for 220 ~ 240V.
⑱	Power switch	To be pressed upwards for turning on
⑲	Light source housing	With a halogen lamp for the visible region and a deuterium lamp for the ultraviolet region

3.2 Sample Compartment



(a) Inside View of the Sample Compartment (b) Removal of the Sample Compartment

Fig. 3.2 Sample Compartment

	Name	Description
①	Reference cell holder	
②	Sample cell holder	
③	Cell holder fixing screw	
④	Fixing pin	Used for positioning the sample compartment at installation
⑤	Positioning hole	Used for positioning the sample compartment at installation
⑥	Boss	Tapped holes are used only for specified attachments

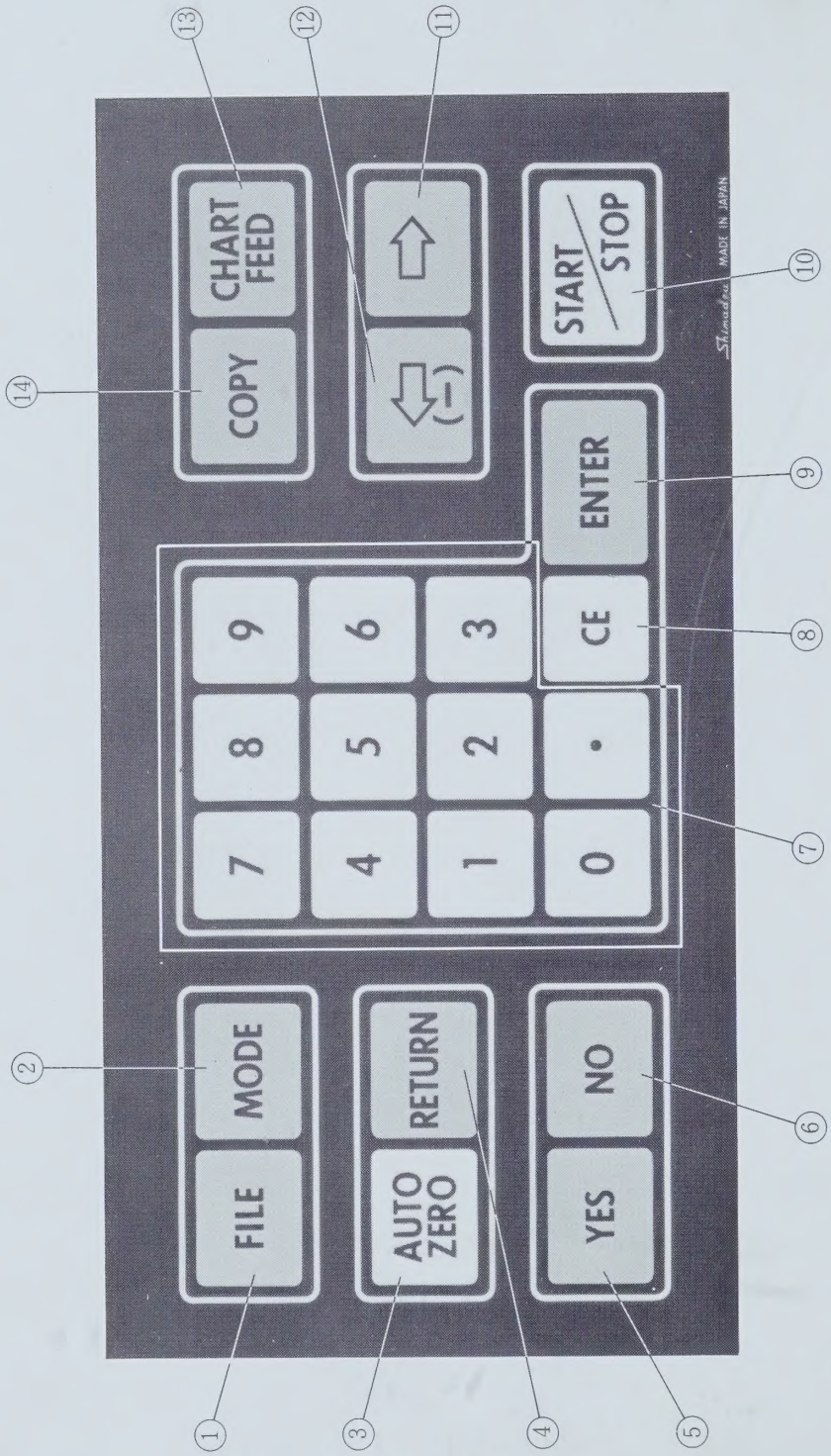


Fig. 3.3 Keyboard

Table 3.1 shows the functions of keys (Refer to Fig. 3.3).

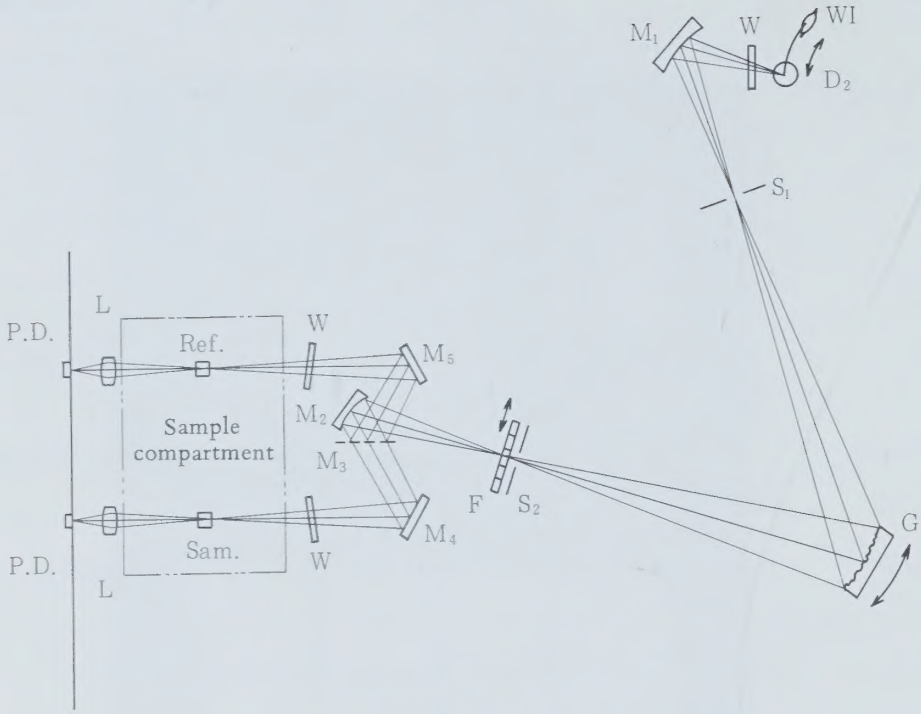
Table 3.1 Description of the Keyboard

	Name	Function	Operation
①	File key	Used to recall the stored files.	[FILE] number [ENTER]
②	Mode select key	Used to select the mode.	[MODE] number [ENTER]
③	Auto zero key	Used to set ABS zero automatically.	Independently
④	Return key	Used to recall the parameter setting display.	Independently
⑤	Yes key	Used for the answer YES to question Y/N? in CRT dialogue.	Independently
⑥	No key	Used for the answer NO to question Y/N? in CRT dialogue.	Independently
⑦	Numeric keys	Used to enter a numerical value in CRT dialogue. The [ENTER] key should be pressed as shown on the right column.	number [ENTER]
⑧	Clear entry key	Used to clear off the preceding numerical entries. Each time it is depressed, the last alpha or numeric is cleared.	Independently
⑨	Enter key	Used to enter numerical values.	Refer to ⑦.
⑩	Start/stop key	Used to start or stop a measurement. A sample can be measured under the preset analytical conditions by pressing this key. The measurement can be stopped in transit with this key.	Independently
⑪	Right shift key	Used to shift the cursor to the right.	Independently
⑫	Left-shift/minus key	(1) Used to shift the cursor to the left. (2) Used to enter the negative sign (minus sign) for numerical entries.	(1) Independently (2) Refer to ⑦.
⑬	Chart feed key	Used to feed only the chart. Feeding is accomplished while pressing this key.	Independently
⑭	Copy key	Used to get the CRT hard-copy (screen dump).	Independently

3.4 Measuring System

3.4.1 Optical System

Fig. 3.4 shows the optical system.



D_2:	Deuterium lamp	W:	Window plate
WI:	Halogen lamp	$M_1 \sim M_5$:	Mirrors, M_3 is a half-mirror
F:	Filter	L:	Lens
G:	Grating	Sam.:	Sample cell
S_1:	Entrance slit	Ref.:	Reference cell
S_2:	Exit slit	P.D.:	Photodiode

Fig. 3.4 Optical System

The light beam emitted from the light source (deuterium lamp D_2 or halogen lamp WI) is reflected by the mirror M_1, and directed into the monochromator. The light source lamps are interchanged automatically according to the wavelength range as follows:

D_2 lamp: from 200nm to light source switching wavelength minus 0.1nm WI lamp: from light source switching wavelength to 1100nm The light source switching wavelength can be set to any value within the range of 295nm to 364nm. Its initial value is 350.5nm.

The light source position is automatically controlled for maximum sensitivity and the light source condenser mirror is located outside the light source housing so as not to be exposed to heat rays and ozone.

All the optical elements excluding the light source are sealed from the external atmosphere by the window plate W so as to be dust free.

The slit width of the monochromator is fixed at 2nm.

The grating is a Shimadzu-made 900 lines/mm aberration-corrected concave holographic grating.

The light beam coming from the monochromator is passed through the stray-light cut-off filter F, reflected by the mirror M_2, and then split by the half mirror M_3 into the sample and reference beams. Each beam passes through the respective cell to the detector (photodiode).

An image of the exit slit S_2 appears near the cell position in the sample compartment. Its crosssectional size is as follows:

Width: Nearly 1.2mm

Height: Nearly 16mm

Since the width of the light beam at the cell position is wider than 1.5mm, the cell holder with mask (P/N 204-06896) is required when using micro cell.

3.4.2 Electrical System

Fig. 3.5 shows the electrical system. The main control element is a micro-computer CPU which controls the light source lighting, light source switching, filter switching, wavelength scan, CRT display, keyboard, and printer.

The sample and reference beams are detected by photodiode detectors, logarithmically converted, and their difference is obtained by a differential amplifier. Some amount of signal is then added so that the signal zero level may correspond to ABS zero. The signal then passes through the amplifiers (1) and (2). Amplifier (1) serves to finely adjust the signal level and amplifier (2) serves to apply a GAIN up to 10-fold to the signal. (Its initial value is 1.) Then, after being A/D-converted, the signal is read by the CPU. At the time of initialization, only the reference signal is read for various checkes and corrections.

*** Notes on Zero Adjustment, Baseline Correction and Auto Zeroing**

When a baseline correction is made, its signal level becomes ABS zero within the corrected wavelength range. On the other hand, when the [AUTO ZERO] key is pressed, the ABS level only at the current wavelength becomes zero. Both of them are similar in function but different in operation.

In the case of a baseline correction, the analog output signal from amplifier (3) is used to automatically correct the signal from the differential amplifier so that nearly zero ABS may be obtained at the starting wavelength. As the full scale of the A/D converter is 5 ABS to cover the measuring range of ±2.5 ABS, absorbances up to nearly 2.5 ABS can be effectively converted to digital signal when practically no analog correction. But, when making the baseline correction with the +1.0 ABS sample inserted in the sample optical path, the analog signal corresponding to the +1.0 ABS is subtracted from the photometric signal and then resultant signal is A/D-converted. And at that time, the A/D converter practically covers the measuring range of +3.5 ABS~-1.5 ABS (5 ABS full scale), after finishing the baseline correction and removing the +1.0 ABS sample and when measuring the unknown samples. A finer correction for digital signals is made by the CPU. Since the analog correction is constant over the whole wavelength range, the effective measuring range changes per wavelength as a function of how much digital correction per wavelength is required to "flatten out" the baseline. For example, the A/D converter range is 5.0 ABS full scale, and therefore if the operator wants to measure samples within the effective range of ±2 ABS (4 ABS total), he must ensure that the baseline he normalizes before measuring his samples stays within the range of ±0.5 ABS (1 ABS total) throughout the entire baseline wavelength range.

In the case of auto zeroing with the [AUTO ZERO] key, only a digital correction is made at the current wavelength and thus the measuring range changes accordingly. For example, when the [AUTO ZERO] key is pressed with a sample of ABS 1.0 inserted in the sample path, the measuring range changes from "+2.5 ABS~-2.5 ABS" to "+1.5 ABS~-3.5 ABS." In this case, the A/D converter covers the measuring range of +2.5 ABS~-2.5 ABS as usual before and after the AUTO-ZERO correction, but reading range of absorbance on the CRT changes to +1.5 ABS~-3.5 ABS.

Take this into account when making a baseline correction or auto zeroing.

*** Notes on Absorbances and Transmittance**

In this spectrophotometer, the output signal from the detector passes through a logarithmic amplifier and therefore the absorbance signal itself is read by the CPU. The full scale of the A/D converter is 5 ABS to cover the measuring range of ±2.5 ABS. Therefore, absorbances up to nearly 2.5 ABS can be measured directly when practically no digital compensation has been performed.

In this system, the transmittance value is computed from the measured absorbance. Strictly speaking, a transmittance of 0% corresponds to absorbance infinity. However, the maximum value in the ABS measuring range is 2.5 ABS and therefore transmittance 0% cannot be obtained in this system. Even if an object such as a shutter block which does not pass light at all is inserted in the sample optical path, the measured transmittance will not indicate the 0%.

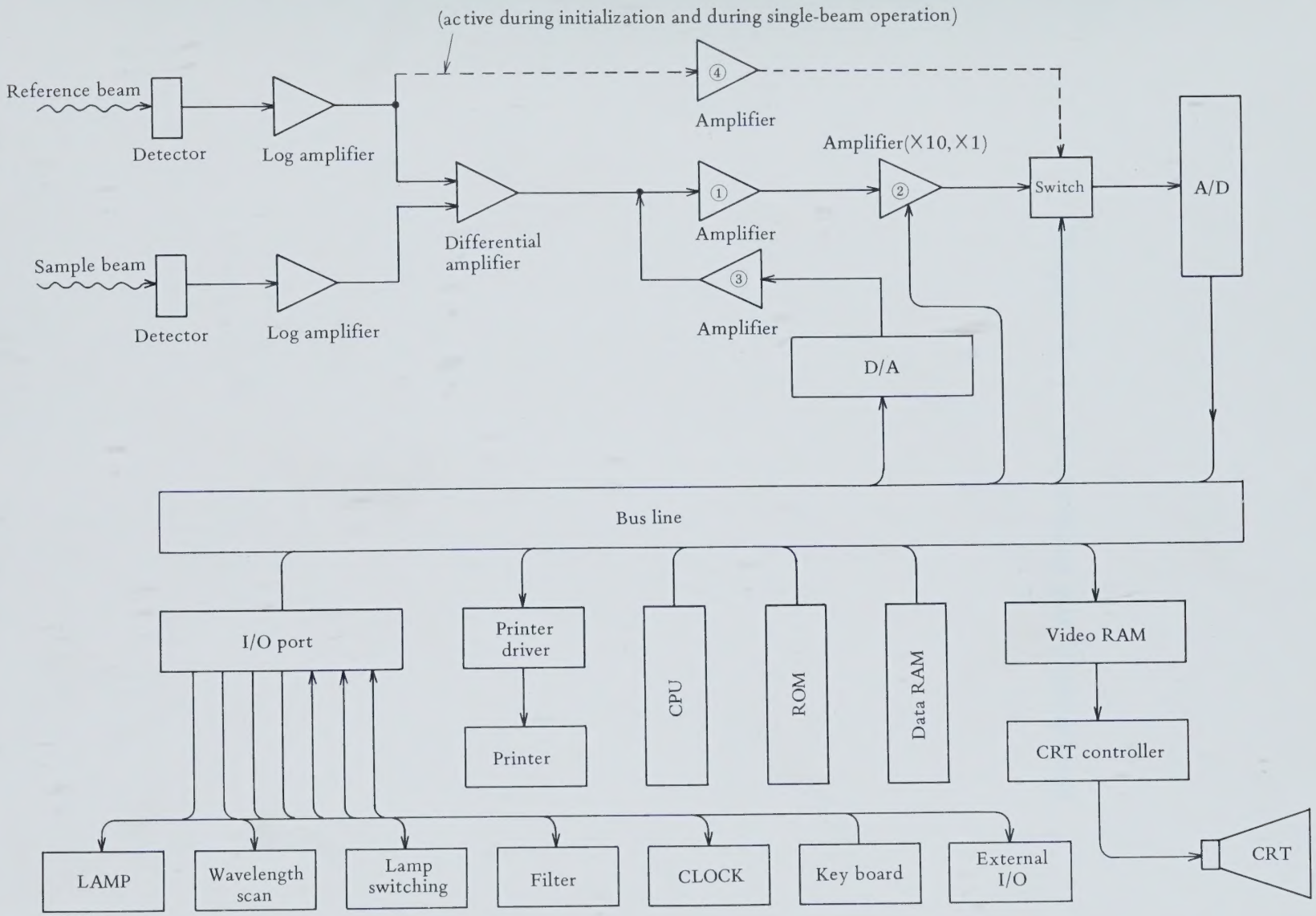


Fig. 3.5 Block Diagram of the Electrical System

Chapter 4 Functions and Operations

4. Functions and Operations

4.1 Basic functions and operations

4.1.1 Automatic Initial Corrections

When being energized, the spectrophotometer makes an initialization with various checks while indicating "INITIALIZATION" on the CRT. If the checks are all right, a baseline correction starts at nearly 1.5 min. after being energized. When the baseline correction is finished, the CRT indicates the basic mode menu and thus the system becomes ready for a measurement.

If an abnormality occurs at a step in the correction process in Fig. 4.1, the appropriate error message is displayed on the CRT. Additionally, baseline correction can be stopped and thus omitted if need be by pressing the [START/STOP] key immediately after the start of the baseline correction. The CRT indicates a wavelength at the lower right-side corner when the baseline correction starts.

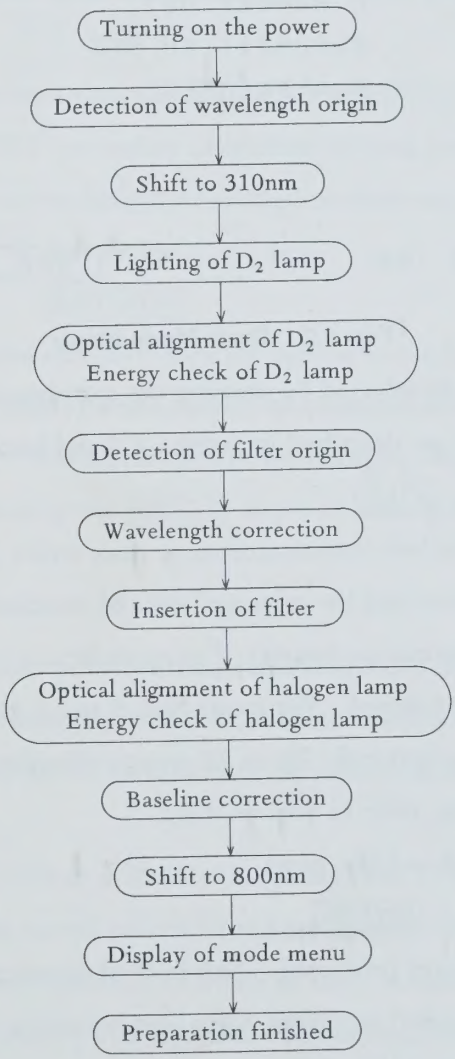


Fig. 4.1 Flow Chart of Automatic Initial Corrections

4.1.2 Selection of Basic Modes . . . . . MODE

This spectrophotometer has nine basic modes. The basic modes are selectable after the automatic initial corrections have been completed or when the MODE key is pressed when the CRT displays "PARAMETER CHANGE Y/N?". In this case, the basic mode menu is indicated on the CRT as shown in Fig. 4.2.

```
MODE No.="1"?
------------------------------------------------------------
                    1.PHOTOMETRIC
                    2.SPECTRUM
                    3.TIME SCAN
                    4.KINETIC
                    5.QUANTITATIVE
                    6.MULTI-COMPONENT
                    7.MEMORY OUT
                    8.CONDITION SET
                    9.ATTACHMENT

10:02 10/05 '84                    800.0NM    0.000A
```

Fig. 4.2 Basic Mode Menu

The desired mode can be selected by pressing the corresponding No. and then the ENTER key. The details of each mode are described in Section 4.2 and later.

4.1.3 File Function . . . . . FILE

It is very convenient for later measurements to store either 1) the measuring parameters or 2) the measuring parameters and the measured data of standard samples (a working curve or a multi-component determination matrix). For mode Nos. 1 ~ 4, only the analytical conditions (measuring parameters) are stored. For mode Nos. 5 and 6, the analytical conditions and the data of standard samples are stored. Up to 20 groups of analytical conditions can be stored. For further details of filing, refer to Section 4.2.2.

To recall a previously stored file, press

FILE (file No.) ENTER

The stored files are battery protected. This backed-up memory effectively lasts for nearly 1 week, but it is recommended to charge it (by simply turning on the UV-160A power switch) for 30 min. every two or three days.

Note:

To protect the content of the backed-up memory, don't disconnect the power plug. Instead, use the power switch to turn the instrument on and off. If the power plug is pulled out with the power switch on, the backed-up memory content may be damaged.

4.1.4 Auto Zeroing ..... [AUTO ZERO]

When the [AUTO ZERO] key is pressed, the baseline signal level is shifted so that the level at the current wavelength becomes zero (e.g. if the monochromator is set to 500nm and the corresponding signal level is 0.2 ABS units, pressing the [AUTO ZERO] key will make the signal level 0.0. Hence, the signal level has been shifted 0.2 ABS units in the negative direction).

4.1.5 Printer Operations ..... [COPY], [CHART FEED]

The printer chart continues to be fed while the [CHART FEED] key is being pressed. A hard copy of the CRT display can be produced in nearly 25 sec. by pressing the [COPY] key.

4.1.6 Cursor Shift ..... [⇦ (−)], [⇨]

If the [NO] key is pressed as an answer to DATA PROCESSING Y/N on a spectrum or time-scanned curve on the CRT (excluding a spectrum derived from basic mode 7 "MEMORY OUT"), the measured value at the desired wavelength or time can be indicated by shifting the cursor position with the [⇦] key or the [⇨] key.

4.1.7 Return Function ..... [RETURN]

The [RETURN] key can be used to return the system to the beginning of the selected basic mode (parameter changing display) when a series of measurements are finished, or while some measurement is being made. This status (parameter changing display) is used for parameter setting and in this status, pressing the [MODE] key will cause the basic mode menu to be displayed.

4.1.8 Timer Function

This spectrophotometer incorporates a timer and thus it can indicate the date and time on the CRT. This timer is also battery protected (Refer to Section 4.1.3 "Backed-up Memory"). The date and time indication can be turned on or off as described in Section 4.10.

4.2 Description of Basic Modes

The nine basic modes are described in Table 4.1. Mode Nos. 1 ~ 6 are measuring modes; Mode No. 7 is used to recall the stored spectra or the stored time-course data; Mode No. 8 is used to set parameters which are used regardless of which of the 6 measuring modes is being executed (common parameters); and Mode No. 9 is used when an optional attachment is connected.

Table 4.1 Description of the Basic Modes

Mode No.	Mode name	Function
1	PHOTOMETRIC	Used to measure the absorbances or transmittances at fixed wavelengths. Various multi-wavelength computations are also possible.
2	SPECTRUM	Used to measure spectra with the wavelength scanned. Various data processings such as data storage, expansion, peak-pick measurement, differentiation and smoothing are also possible.
3	TIME SCAN	Used to measure a time-course variation of absorbance (or transmittance). Various data processings are also possible.
4	KINETIC	Used to measure and display absorbance changes (dA) as well as the absorbance change rate (dA/min) and activity level (dA/min X Factor).
5	QUANTITATIVE	Used for quantitative measurements. Determinations can be made from the results of various computations such as 2/3-wavelength calculation and differentiation.
6	MULTI-COMPONENT	Used for multi-component determination. Both pure and mixed samples can be used as standards. Up to 8 components can be measured.
7	MEMORY OUT	Used to recall the stored spectra or the stored time-course data.
8	CONDITION SET	Used to set the common parameters among the basic modes.
9	ATTACHMENT	Used when an optional attachment is connected.

4.2.1 Changing Analytical Parameters (Conditions)

After a basic mode is selected, it is first necessary to set the analytical parameters (measuring conditions). Below is an example of the parameter setting procedure using the SPECTRUM mode as an example. Fig. 4.3 shows the parameter changing display in the SPECTRUM mode.

```
SPECTRUM        PARAMETER CHANGE Y/N ?

        1.λS= 800.0NM     λE= 400.0NM
        2.MEASURE(ABS/T%)=ABS
        3.UPPER=+2.00A     LOWER=+0.00A
        4.SCAN SPEED=FAST
        5.CYCLE      T=  60SEC   N= 1
        6.OVERLAY              NO
        7.COPY                 NO
        8.SURVEY SCAN          NO
        9.FILE

21:13  2/04 '85                  800.0NM    0.001A
```

Fig. 4.3 Parameter Changing Display

For example, the procedure for changing the measuring range from "2.00 ~ 0.00 Abs" to "1.50 ~ 0.00 Abs" is shown as follows: (Note: the symbol □ represents the flashing cursor on the CRT screen)

Key operation	CRT display	Description
	PARAMETER CHANGE Y/N ?	If a parameter is to be changed press the [YES] key, and then enter the corresponding parameter No. Then, enter a new value for the parameter indicated by the flashing cursor. At this time, if the entry is erroneous, press [CE] and re-enter the new value. The positive sign "+" is not necessary. When the parameter indicated by the flashing cursor is not to be changed, directly press the [ENTER] key. When the parameter changing procedure is completed, press the [NO] key to terminate the procedure.
[YES]		
	PARAMETER NUMBER ? " "	
[3] [ENTER]		
	3. UPPER = [+] 2.00A LOWER = + 0.00A	
[1] [.] [5]		
	3. UPPER = 1.5 A LOWER = +0.00A	
[ENTER]		
	3. UPPER = +1.50A LOWER = [+]0.00A	
[ENTER]		
	3. UPPER = +1.50A LOWER = +0.00A	
[NO]	PARAMETER CHANGE Y/N ?	

In the case of parameter Nos. 2, 6, 7, and 8 (MEASURE, OVERLAY, COPY and SURVEY SCAN*), it is only necessary to select the required parameter No. for changing the parameter because these parameters only have two conditions available.

4.2.2 File Storage

Having the ability to store in files previously set operating parameters and measured standard sample data enhances the efficiency of the system. This file storage can be made in each of the basic modes. For basic mode Nos. 1, press [YES], [7], and [ENTER] to select a FILE. This is usually done at the end of the parameter changing procedure (same procedure for basic mode Nos. 1 ~ 4). On the other hand, for basic mode Nos. 5 and 6, press the [RETURN] key to return the system to the parameter changing display and then press [YES], (number of FILE item), and [ENTER] only when the standard sample measurement is completed. This will result in filing the parameters and the measured standard sample data.

*Note: Survey scan is selected when the customer, for convenience, desires to scan as rapidly as possible for the given scanning speed (FAST, MED, or SLOW) he has already selected. This is accomplished by fixing the sampling interval (see Table 4.3) at 1nm independent of the wavelength range selected.

Then enter the desired file No. with the [ENTER] key while referring to the filing mode display on the CRT shown in Fig. 4.4. Fig. 4.4 shows some example file names.

```
                    FILE No.=" 1"
 ------------------------------------------------------------
        1.BASE-L 1          11.EXT-CHA
        2.BASE-QNJ          12.LIGHTQ J
        3.BASE-L 3          13.RESPONSE
        4.                  14.DRIFTQHJ
        5.HG-CURVE          15.RUNNING
        6.W-B-LQ J          16.QUANT-1
        7.RESOLVE           17.NLWC        *
        8.STRAYQOJ          18.
        9.PHOTO-AC          19.
       10.ENERGQBJ          20.

18:09 11/07 '84                    [1100.0NM    0.000A]
```

Fig. 4.4 Filing Display on the CRT

When the file No. is entered, the CRT display changes as shown in Fig. 4.5. Enter the desired file name of up to 8 characters by character shooting. More specifically, shift the cursor with the [⇦ (−)] and [⇨] keys to the desired character in the top line, and then press the [ENTER] key. If the character entry is erroneous, press the [CE] key. To complete the file name entry, shift the cursor to *END and press the [ENTER] key.

The filing capacity is described as follows: Up to 20 sets of analytical parameters can be stored. Up to 20 sets of linear working curves can be stored. Recall from Section 4.1.3 that for mode Nos. 1 ~ 4, only the analytical parameters are stored whereas for mode Nos. 5 and 6, the analytical parameters AND the standard sample data are stored. However, please observe the following restrictions. Up to a maximum of 6 polygonal working curves can be stored. Only one matrix for multi-component determination can be stored. A polygonal working curve and a matrix for multi-component determination cannot exist at the same time.

The file name for a polygonal working curve is automatically identified by an "*" mark in the rear of the file name and the file name for a matrix for multi-component determination is automatically identified by a "**" mark.

It is not necessary to delete a FILE for you to place a new set of operating parameters with or without standard sample data. The UV-160A has overwriting capability. Therefore, the

following general statement applies. Among the basic modes of PHOTOMETRIC, SPECTRUM, TIME SCAN, KINETIC, QUANTITATIVE using a linear working curve, QUANTITATIVE using a non-linear working curve, and MULTI-COMPONENT, any of these modes can be overwritten by any of these modes. However, the following restrictions apply:

You CANNOT overwrite

- a MULTI-COMPONENT over a MULTI-COMPONENT
- a QUANTITATIVE with a non-linear working curve over a QUANTITATIVE with a non-linear working curve IF there are already 6 QUANTITATIVES with non-linear working curves present
- a MULTI-COMPONENT over a QUANTITATIVE with a non-linear working curve
- a QUANTITATIVE with a non-linear working curve over a MULTI-COMPONENT

```
ABCDEFGHIJKLMNOPQRSTUVWXYZ 0123456789+-*END
            FILE NAME(MAX 8 CHR.)? "        "
     1.BASE-L 1          11.EXT-CHA
     2.BASE-QNJ          12.LIGHTQ J
     3.BASE-L 3          13.RESPONSE
     4.                  14.DRIFTQHJ
     5.HG-CURVE          15.RUNNING
     6.W-B-LQ J          16.QUANT-1
     7.RESOLVE           17.NLWC       *
     8.STRAYQOJ          18.
     9.PHOTO-AC          19.
    10.ENERGQBJ          20.

18:09 11/07 '84                  1100.0NM    0.000A
```

Fig. 4.5 Character Shooting Display for File Name

4.3 PHOTOMETRIC Mode

This mode is used to make measurements at fixed wavelengths (without wavelength scanning nor time scanning). Data processings such as the two/three-wavelength calculation, 4-data arithmetic operations and 5-wavelength determination are possible.

In addition, the results of one-wavelength measurements are stored automatically and successively into the memory. And their distribution can be displayed in MEMORY OUT mode (Refer to 4.9).

The absorbance values measured at each wavelengths and used for 2λ/3λ/4D calculations have more resolution than the displayed absorbance values. And so the manualy-calculated 2λ/3λ/4D values using the absorbances displayed on the CRT are sometimes little different from the displayed values as shown in Fig. 4.7. But you should know the displayed value is correct.

4.3.1 Data Processings

(1) Two-Wavelength Calculation

The utility of the two-wavelength data processing program is its ability to calculate the unknown concentration of a component of interest found in a mixture containing both a component of interest and an unwanted interfering component. It can accomplish this by taking advantage of the following mechanism: the absorbance difference between 2 points on the mixture spectra is directly proportional to the concentration of the component of interest INDEPENDENT of the interfering component. Later in this discussion, attention will be paid to the mathematical basis of this mechanism.

The use of this program requires that the operator has available separate vessels of the pure component of interest and of the pure interfering component. Their specific concentrations are irrelevant provided that such a concentrated sample, when measured, allows the detector to operate within its specified usable absorbance range (−2.0 Abs ~ +2.0 Abs). Please refer to figure 4.6 for the following discussion.

Typically, the operator begins by determining IF he has an interfering component (C) in a mixture (A) in which he wants to analyze a specific component of interest (B). The first step is to perform a spectral recording of the pure component of interest and determine the wavelength at which maximum absorbance is achieved (see Sections 4.4, 4.4.1 (3), and 4.1.6). Next, the same operation is performed using the pure interfering component. The results of these operations will give the operator 2 maximum absorbing wavelengths.

Select the PHOTOMETRIC basic mode and further select the 2λ entry under the parameter of PROCESSING. Enter the two wavelengths you obtained above. Place the pure component of interest in the sample holder and depress the START/STOP key. When the results are printed, observe the data under the column A1/A2. This value is the ratio of absorbances of the pure component of interest. Now remove the pure component of interest and replace it with an unknown solution. Depress the START/STOP key. Observe the data under the column A1/A2. If the value is identical to the value obtained for the pure component of interest, then the unknown solution in fact is composed of the pure component of interest only (or another component exists in the solution but doesn't absorb in the same wavelength region as the component of interest). However, if the value is different, then this confirms the presence, in the unknown sample, of an interfering component. Given that an interfering component has been detected, please observe the following information.

When the 2λ method is used to eliminate the effects of an interfering component, two

specific wavelengths are used: (1) the wavelength λ_1 at which maximum absorbance occurs in the pure component of interest (which the operator determined above) and (2) a second wavelength λ_2. λ_2 is the wavelength at which the absorbance of the interfering component is equal to the absorbance of the interfering component at λ_1. If, with regard to the operator's specific interfering component, this situation doesn't exist (refer to Fig. 4.8), then the 2λ program is unusable. The 3λ program would then be used (see Section 4.3.1(2)). Given that the interfering component's spectra conforms to the 2λ requirement, λ_2 is determined as follows:

(1) In the SPECTRUM basic mode (see Section 4.4), measure the pure interfering component spectrum.

(2) Using the cursor function (see Section 4.1.6), set the wavelength at λ_1 and observe the corresponding data value (Abs).

(3) Move the cursor to other wavelength positions until the same photometric data value is observed.

(4) The wavelength at which this data value is observed is λ_2.

(5) Finally, check the λ_2 as follows.

Prepare the samples of pure interfering component which have the different concentration. And measure them in two wavelength calculation in the PHOTOMETRIC basic mode.

If the λ_1 and λ_2 were properly determined, the results of these measurement shows the same value (Abs 0).

When the result of the measurement of a conc sample does not shows Abs 0, adjust λ_2 so as to shows Abs 0.

Now that the operator knows λ_1 and λ_2 for his particular application, negating the effect of the interfering component in terms of his desire to quantitate the component of interest.

The procedure is as follows:

(1) Select the PHOTOMETRIC basic mode.

(2) Select the 2λ entry under the PROCESSING parameter.

(3) Enter λ_1 and λ_2.

(4) Place a known concentration mixture solution (a standard containing the component of interest and the interfering component) in the sample holder.

(5) Press the START/STOP key.

(6) Repeat step (4), (5) with different concentration standards for as many points as are

required to establish an effective calibration curve.

(7) Observe the data value under the column heading $A_1 - A_2$.

(8) Manually plot $(A_1 - A_2)$ versus concentration (this is the working calibration curve).

(9) Place an unknown mixture solution in the sample holder.

(10) Depress the [START/STOP] key.

(11) Observe the $A_1 - A_2$ value and extract the unknown concentration of the component of interest from the working curve.

For the following mathematical discussion of the mechanism used in the 2λ program, please refer to Fig. 4.6.

Let us now define all the symbols in Fig. 4.6.

A = spectra of the unknown mixture containing both a component of interest and an interfering component

B = spectra of the pure component of interest

C = spectra of the pure interfering component

A_{A1} = absorbance of the mixture at λ_1

A_{B1} = absorbance of the component of interest at λ_1

A_{C1} = absorbance of the interfering component at λ_1

A_{A2} = absorbance of the mixture at λ_2

A_{B2} = absorbance of the component of interest at λ_2

A_{C2} = absorbance of the interfering component at λ_2

According to Beer's Law,

$\frac{I}{I_0} = e^{-K \cdot C}$ where

I_0 = incident light intensity onto the sample

I = that amount of light intensity that passes through the sample and strikes the detector

e = exponential

K = absorption coefficient for the specific sample at a specific wavelength

C = concentration of the sample

thus, $-\log \frac{I}{I_0} = K \cdot C$

The term on the left side of the above equation is equivalent to the absorbance (ABS) of a sample. Therefore,

$$ABS = K \cdot C$$

As can be seen by the above equation, the absorbance of a sample is directly proportional

to the sample's concentration.

The following mathematical discussion will show that the absorbance difference between 2 points (λ_1 and λ_2) on the mixture spectra is directly proportional to the concentration of the component of interest INDEPENDENT of the interfering component. Once again, refer to Fig. 4.6 for the following mathematical discussion.

since $A_{A1} = A_{B1} + A_{C1}$ and $A_{A2} = A_{B2} + A_{C2}$

then $A_{A1} - A_{A2} = (A_{B1} + A_{C1}) - (A_{B2} + A_{C2})$

$$= (A_{B1} - A_{B2}) + (A_{C1} - A_{C2})$$

Since the operator has chosen λ_2 such that $A_{C1} = A_{C2}$, then

$$A_{A1} - A_{A2} = A_{B1} - A_{B2}.$$

Let b = concentration of the pure component of interest B

d = concentration of the pure interfering component C

then from Beer's Low we get

$$A_{B1} = K_{B1} \cdot b \text{ and } A_{B2} = K_{B2} \cdot b$$

where K_{B1} = absorption coefficient of the component of interest at λ_1

K_{B2} = absorption coefficient of the component of interest at λ_2

therefore,

$$A_{A1} - A_{A2} = (K_{B1} \cdot b) - (K_{B2} \cdot b)$$

$$= (K_{B1} - K_{B2})b$$

Since the expression $(K_{B1} - K_{B2})$ is simply a constant, then

$$A_{A1} - A_{A2} = (\text{constant})(b)$$

Thus, it clearly can be seen that the absorbance difference ($A_{A1} - A_{A2}$) between 2 points (λ_1 and λ_2) on the mixture curve (A) is directly proportional to the concentration (b) of the component of interest (B) INDEPENDENT of the interfering component (C).

Typical interfering components are rises in the baseline due to scattering by turbidity or the presence of small bubbles in the sample.

Fig. 4.7 shows an example of the result of a two wavelength calculation.

(2) Three-Wavelength Calculation

The utility of the three-wavelength data processing program is identical to that of the 2λ program. However, the 3λ program is used when, for a particular component of interest and interfering component, identical absorbance values on the interfering component's spectrum at λ_1 and another wavelength don't exist (see Fig. 4.8). In this instance, λ_1, λ_2, and λ_3 are chosen so that the points S, T, and U on the curve of the interfering component

C may be along a straight line. Through a series of several geometric mathematical equations and computations, the line segment $A_2 - A_4$ is directly proportional to the concentration of the component of interest INDEPENDENT of the interfering component. The value A_4 has the value of

$$A_4 = \frac{(\lambda_1 - \lambda_2)A_3 + (\lambda_2 - \lambda_3)A_1}{\lambda_1 - \lambda_3}$$

Fig. 4.9 shows an example of the result of the three-wavelength calculation. The operator can obtain the unknown concentration of the component of interest from a calibration curve plotting the "RESULT" (from the 3λ printout) versus known concentrations of prepared standards (each standard containing a known concentration of the component of interest plus the interfering component).

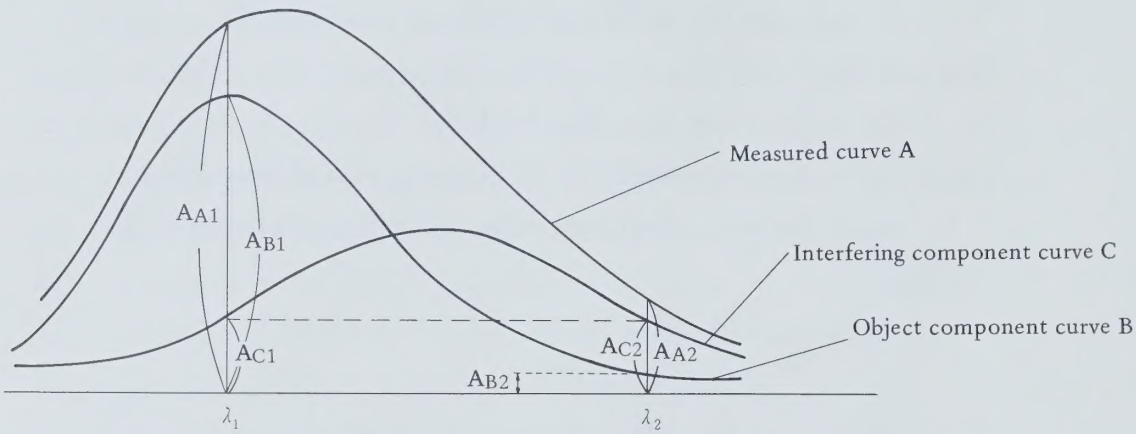


Fig. 4.6 Illustration of the Two-Wavelength Calculation

```
            *** PHOTOMETRIC ***
 λ    585.5   648.0
No.   A1      A2      A1-A2   A1/A2
 ---------------------------------------
   1  0.000   0.000   0.000   1.0000
   2  0.000   0.000   0.000   1.0000
   3  1.605   0.047   1.557   33.551
   4  1.605   0.047   1.557   33.551
```

Fig. 4.7 An Example of the Result of a Two-Wavelength Calculation

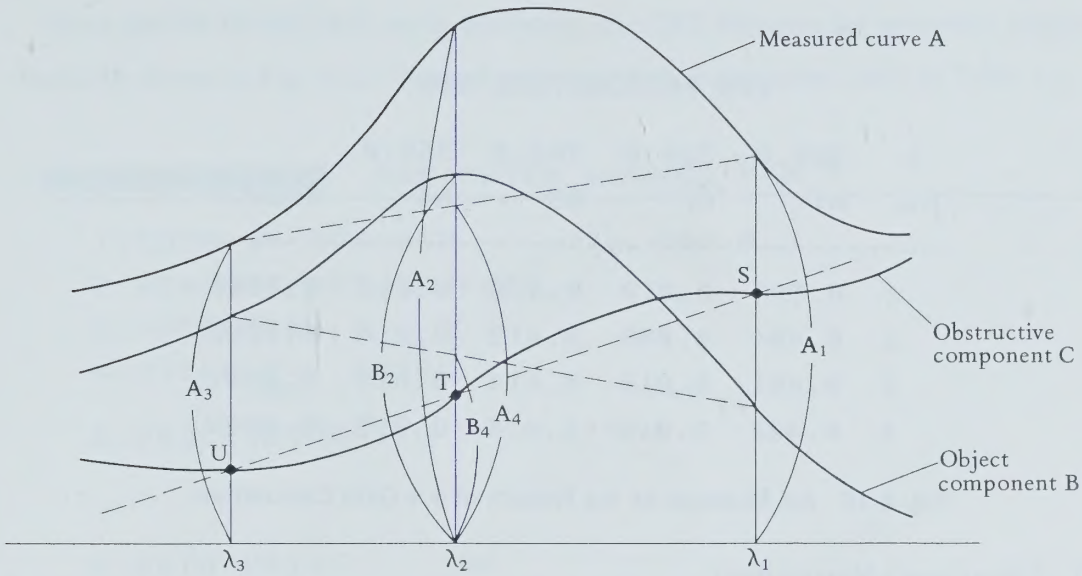


Fig. 4.8 Illustration of the Three-Wavelength Calculation

```
                *** PHOTOMETRIC ***
 λ    605.0   585.5   565.0
No.   A1      A2      A3      RESULT
 ---------------------------------------
   1 -0.000 -0.000  0.000 -0.000
   2  0.217  1.605  0.134  1.428
   3  0.520  1.874  0.359  1.431
```

Fig. 4.9 An Example of the Result of a Three-Wavelength Calculation

(3) Four-Data Calculation

This processing is such that either

$$(K_1A_1 + K_2A_2 + K_3A_3 + K_4A_4) \times K_5 \quad \text{or} \quad \frac{K_1A_1 + K_2A_2}{K_3A_3 + K_4A_4} \times K_5$$

may be selected where $K_1 \sim K_5$ are any desired coefficients to be entered and $A_1 \sim A_4$ are absorbances.

This arithmetic processing is very versatile because the wavelengths and coefficients can be arbitrarily set followed then by absorbance measurements of one or multiple samples (up to 4 max.) at one or multiple wavelengths (up to 4 max.). It is especially useful for somewhat complicated analyses.

Fig. 4.10 shows an example of the results of a 4-data calculation.

*** PHOTOMETRIC ***

λ	368.0	368.0	368.0	368.0	
No.	A1	A2	A3	A4	RESULT
1	0.398	0.010	0.416	0.012	0.0960
2	0.404	0.008	0.413	0.014	0.0992
3	0.401	0.010	0.414	0.015	0.0981
4	0.403	0.010	0.414	0.015	0.0988

Fig. 4.10 An Example of the Results of a 4-Data Calculation

(4) 5-Wavelength Measurement

In this measurement, a sample is measured at five different wavelengths.

Fig. 4.11 shows an example of the results of 5-wavelength measurements.

*** PHOTOMETRIC ***

λ	800.0	750.0	700.0	650.0	600.0
No.	A1	A2	A3	A4	A5
1	0.000	-0.000	0.000	0.000	0.000
2	0.633	0.647	0.052	0.047	0.376
3	1.435	1.056	0.716	0.458	0.289
4	1.001	0.892	0.875	1.000	1.009
5	0.606	0.533	0.503	0.545	0.542

Fig. 4.11 An Example of the Results of a 5-Wavelength Measurement

4.3.2 Operation

When the PHOTOMETRIC mode is selected, the CRT indicates the parameter changing display as shown in Fig. 4.12. For a description of each parameter, refer to Table 4.2.

```
PHOTOMETRIC   PARAMETER CHANGE Y/N ?

  1.GOTO λ= 800.0NM      λ1  800.0
  2.MEASURE(ABS/T%)=ABS
  3.SAMPLE No.=    1
  4.CYCLE T=   60SEC
          N=  1
  5.PROCESSING=1λ


  6.DATA PRINT      NO
  7.FILE


18:36 11/07 '84                    800.0NM    0.000A
```

Fig. 4.12 Parameter Changing Display in the Photometric Mode

Table 4.2 Description of the Analytical Parameters in the Photometric Mode

Item [valid values]	Description
1. GO TO λ [200 ~ 1100]	Used to shift the wavelength independent of the measuring wavelengths $\lambda_1 \sim \lambda_5$.
2 MEASURE [ABS, T%]	Used to select absorbance (ABS) or transmittance (T%). However, this parameter (MEASURE) is fixed at ABS in the case of PROCESSING = 2λ, 3λ or 4D. irrespective of the setting.
3 SAMPLE NO. [0 ~ 9999]	Indicates the sample No. It increases automatically by one after each measurement.
4 CYCLE T [0 ~ 9999] CYCLE N [1 ~ 99]	Parameters for repeated measurements. The cycle time T is defined as a time in sec. between the beginning of two successive measurements. If the measuring time is longer than T, the next measurement starts immediately. N is a repetition number, with N = 1 for a single measurement (without repetition). In the case of PROCESSING = 4D, then N = 1 only.
5 PROCESSING [1λ, 2λ, 3λ, 4D, 5λ] $\lambda_1 \sim \lambda_5$ [200 ~ 1100] $K_1 \sim K_5$ [0.0001 ~ 9999.9] (Zero and negative values permissible)	1λ : Measurement at a fixed wavelength ..... with one parameter λ_1 2λ : Two-wavelength calculation ..... with two parameters λ_1, λ_2 3λ : Three-wavelength calculation ..... with three parameters $\lambda_1, \lambda_2, \lambda_3$ ($\lambda_1 > \lambda_2 > \lambda_3$)

Item [valid values]	Description
	4D : 4-data calculation ..... with parameters $\lambda_1 \sim \lambda_4$ and $K_1 \sim K_5$ ..... selection of one of two following equations $(K_1A_1 + K_2A_2 + K_3A_3 + K_4A_4) \times K_5$; $\frac{K_1A_1 + K_2A_2}{K_3A_3 + K_4A_4} \times K_5$ 5λ : 5-wavelength measurement ..... with five parameters $\lambda_1 \sim \lambda_5$
6. DATA PRINT [YES, NO]	YES : Data are output on the CRT and the printer. NO : Data are output on the CRT.
7. FILE	To be selected for filing (file storage).

Operating Procedure

Remarks: • If for a given step No. X in the table below there appears nothing in the column labelled "Next step", then proceed to step X +1.

• [ ] below [numerical entry] shows the range of valid entries.

Step	Operation and CRT display	Key operation	Next step
1	Select the basic mode No. 1 (PHOTOMETRIC).	[MODE] [1] [ENTER]	
2	PHOTOMETRIC PARAMETER CHANGE Y/N ? 1.GOTO λ= 800.0NM λ1 800.0 2.MEASURE(ABS/T%)=ABS 3.SAMPLE No.= 1 4.CYCLE T= 60SEC N= 1 5.PROCESSING=1λ 6.DATA PRINT NO 7.FILE		
3	Set all analytical parameters.	Refer to 4.2.1.	
4	Start a measurement. In the case of 1λ, 2λ, 3λ, 5λ: In the case of 4D:	[START/STOP]	 5 6
5	If there is a next sample: If there is no next sample:		4 7
6	DATA ○, PRESS START KEY Measure $A_1 - A_4$ while changing samples if necessary.	[START/STOP] [START/STOP] [START/STOP]	5
7	End The next measurement can be started with the [START/STOP] key (go to Step 4). The system can be returned to Step 2 with the [RETURN] key; then, the basic mode menu appears when the [MODE] key is pressed.		

4.4 SPECTRUM Mode

This mode provides a wavelength scan and data processings (such as data storage, expansion/compression, peak detection, differentiation, smoothing, data outputting at regular wavelength intervals and outputting to plotter) for measured spectra.

4.4.1 Data Processings for Spectra

(1) Data Storage (SAVE)

It is convenient for later use to save measured spectra. However, the saved data are not battery protected. There are two channels CH1 and CH2 to save two spectra in total. The operator can elect to recall one spectra from either CH1 or CH2 onto the CRT or can recall both the spectra from CH1 and CH2 and display them on the CRT in an overlapping manner.

In recalling and overlapping the saved two spectra, it is necessary that their measuring wavelength ranges and SURVEY SCAN parameter coincide with each other, but it is permissible that their ordinate ranges differ. When they are different, the ordinate scale for output (recalling) becomes that for CH1.

Fig. 4.13 shows spectra which are saved, processed, and recalled. In this example, a measured spectrum is first saved in CH1. Its first-order derivative is obtained and then saved in CH2. The spectra saved in CH1 and CH2 are recalled on the CRT in an overlapping manner.

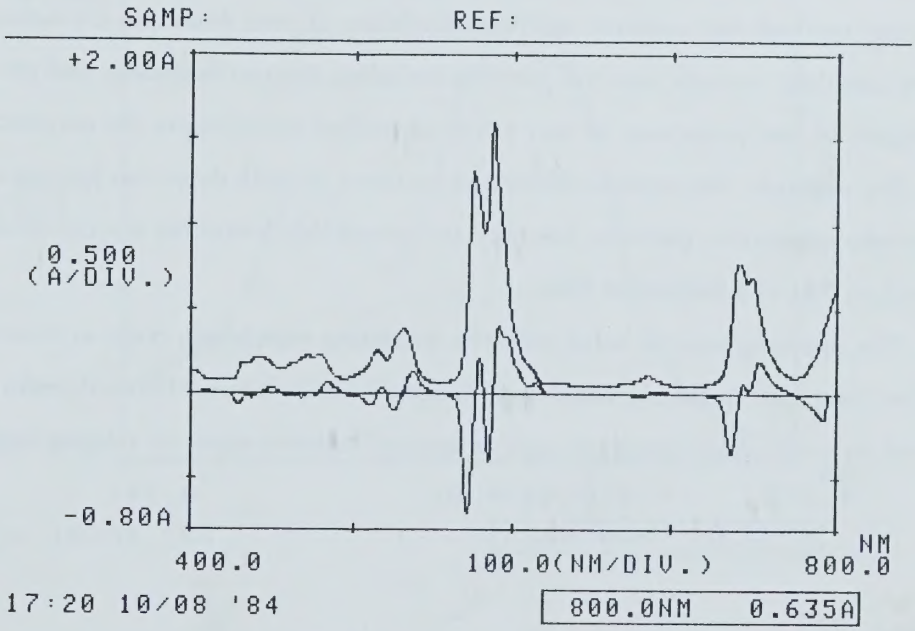


Fig. 4.13 Example of Processing Where Spectra Are Saved, Processed, and Recalled

Note:

When one of the basic modes other than Mode Nos. 1, 2, 3, 7 and 8 is used, the saved spectra or time-course data will be erased.

(2) Expansion/Compression of Spectra

Measured spectra can be expanded or compressed. The abscissa scale (wavelength axis) cannot be compressed (namely, the wavelength range cannot be broadened). The ordinate scale can be compressed or expanded. A spectrum can be expanded or compressed by re-setting the starting wavelength, the ending wavelength, the upper signal full scale limit, and the lower signal limit. Fig. 4.14 shows an example of this processing. In this example, a spectrum measured in the ranges of 800 ~ 400nm and +2.00A ~ 0.00A is expanded for the section surrounded by ☐ .

(3) Peak Detection

In this processing, peaks and valleys on a measured spectrum are found and their wavelengths and measured values are printed out. On the CRT, the peaks and valleys are marked by cursors which are located above and below them respectively.

This peak detection algorithm employs a 6-point successive comparison method where a peak is identified if there are more than six successive increases and then more than six successive decreases at regular sampling wavelength intervals. And a valley is identified similarly. More than 6 successive increases and decreases are essential for one peak or valley. In this method, the accuracy and reproducibility of peak detection are naturally affected by the sampling intervals, spectral patterns including spectral sharpness, and the noise level. Therefore, real peaks may or may not be identified according to the parameters selected.

For example, the reproducibility and accuracy of peak detection becomes worse for broader absorption patterns, but they are remarkably better for sharper absorption patterns such as that of a didymium filter.

The sampling interval varies with the measuring wavelength range as shown in Table 4.3. Therefore, the measuring wavelength range should be below 100nm if peaks are to be identified on a very sharp spectrum such as those of benzene vapor or a deuterium lamp.

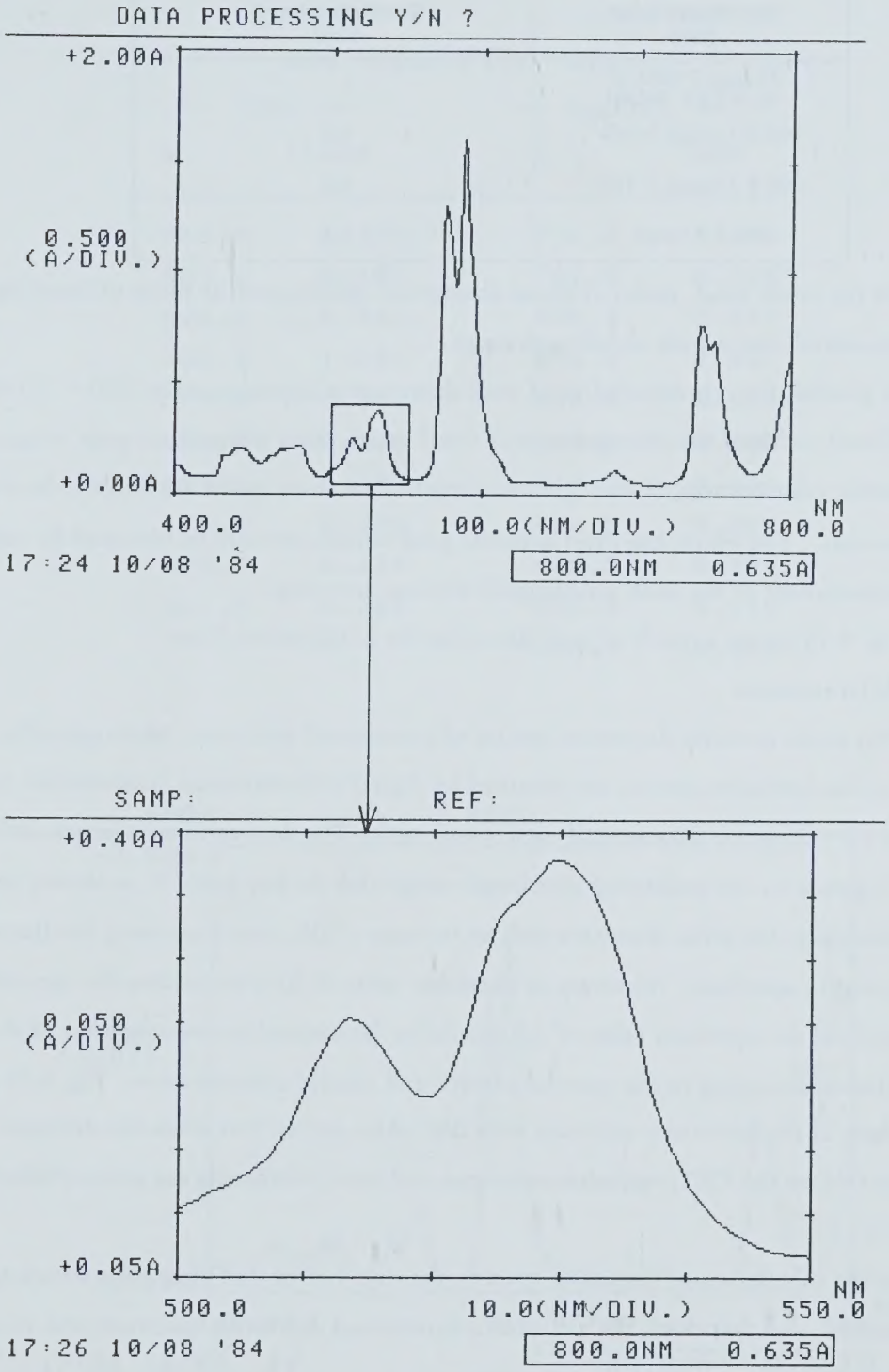


Fig. 4.14 Example of an Expanded Spectrum

Table 4.3 Relation Between the Measuring Wavelength Range and the Sampling Interval

Wavelength range (nm)	Sampling interval (nm)
λ range $>$ 500, or SURVEY SCAN	1
500 $\geqq \lambda$ range $>$ 200	0.5
200 $\geqq \lambda$ range $>$ 100	0.2
100 $\geqq \lambda$ range	0.1

On the other hand, peaks of broad absorption spectra such as those of usual liquids can be measured over a wide wavelength range.

In general, the reproducibility of peak detection is approximately 1/10 ~ 1/100 times the half-band width of the absorption peak itself. And, since printed-out peak values are dynamic values produced during a wavelength scan, sharp peaks are liable to be slightly erroneous. Therefore, the most accurate peak values can only be obtained by making a measurement at the peak wavelengths without scanning.

Fig. 4.15 shows a result of peak detection for a didymium filter.

(4) Differentiation

This mode provides derivative spectra of a measured spectrum. More specially, the 1st ~ 4th order derivative spectra are obtained by digital differentiation (convolution method) with 17 ~ 25-point data around each wavelength. The derivative wavelength difference $\Delta\lambda$ depends on the measuring wavelength range and the key entry N, as shown in Table 4.4.

Generally, the noise decreases with an increase of $\Delta\lambda$, thus decreasing the fluctuation in a derivative spectrum. However, an excessive value of $\Delta\lambda$ deteriorates the spectral resolution. Therefore, the optimum value of $\Delta\lambda$ should be determined in consideration of the noise and resolution according to the spectral pattern and sample concentration. Fig. 4.16 shows changes of the derivative spectrum with $\Delta\lambda$. Also notice that when the derivative spectra is presented on the CRT, optimum auto span and zero positioning are accomplished automatically.

In the calculation of derivative spectra, the data before and after each wavelength are processed, and therefore, the values of a determined derivative spectrum near its start and end wavelengths are naturally erroneous.

*** PEAK-PICK ***

-- PEAK --		-- VALLEY --	
λ	ABS	λ	ABS
740.5	0.766	776.0	0.100
685.0	0.109	707.0	0.048
626.0	0.062	655.5	0.047
585.5	1.603	620.0	0.057
573.0	1.306	580.5	0.938
529.5	0.378	551.0	0.065
513.5	0.253	519.5	0.194
479.5	0.225	494.5	0.084
472.5	0.220	475.5	0.204
441.0	0.208	455.5	0.140
		420.5	0.078

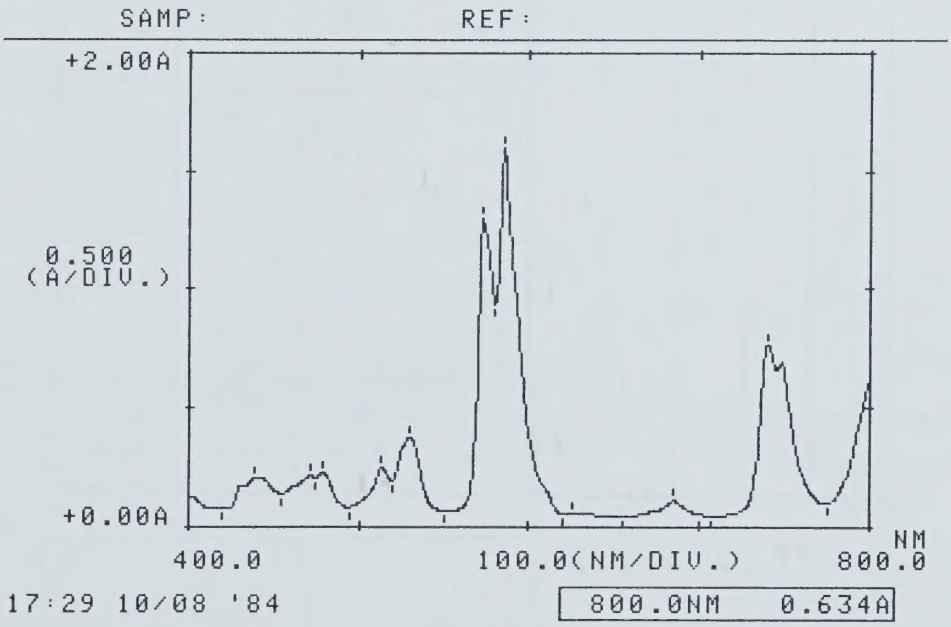
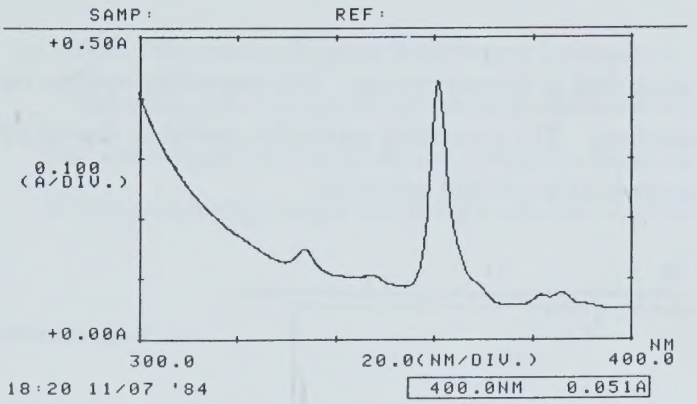


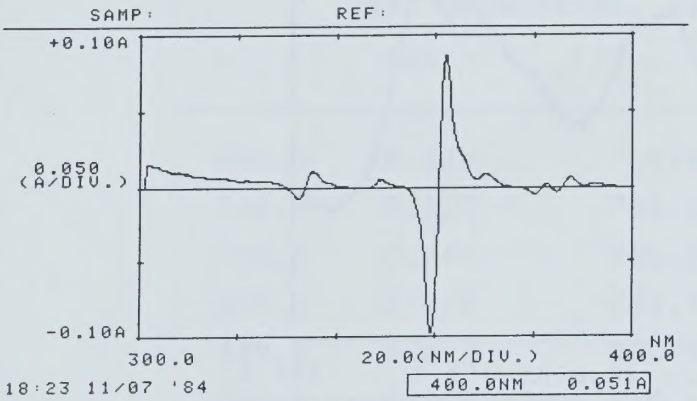
Fig. 4.15 An Example of Peak Detection of a Didymium Filter

Table 4.4 Relation Between the Key Entry N and the Derivative Wavelength Difference Δλ

	Measuring wavelength range (nm)				Δλ (nm)			
	λ range > 500	500≧λ range > 200	200≧λ range > 100	100≧λ range	1st order	2nd order	3rd order	4th order
				1	0.8	0.7	0.7	0.6
			1	2	1.6	1.4	1.4	1.2
				3	2.4	2.1	2.1	1.8
			2	4	3.2	2.8	2.8	2.4
		1		5	4.0	3.5	3.5	3.0
			3	6	4.8	4.2	4.2	3.6
				7	5.6	4.9	4.9	4.2
			4	8	6.4	5.6	5.6	4.8
				9	7.2	6.3	6.3	5.4
	1	2	5		8.0	7.0	7.0	6.0
			6		9.6	8.4	8.4	7.2
			7		11.2	9.8	9.8	8.4
		3			12.0	10.5	10.5	9.0
			8		12.8	11.2	11.2	9.6
N			9		14.4	12.6	12.6	10.8
	2	4			16.0	14.0	14.0	12.0
		5			20.0	17.5	17.5	15.0
	3	6			24.0	21.0	21.0	18.0
		7			28.0	24.5	24.5	21.0
	4	8			32.0	28.0	28.0	24.0
		9			36.0	31.5	31.5	27.0
	5				40.0	35.0	35.0	30.0
	6				48.0	42.0	42.0	36.0
	7				56.0	49.0	49.0	42.0
	8				64.0	56.0	56.0	48.0
	9				72.0	63.0	63.0	54.0



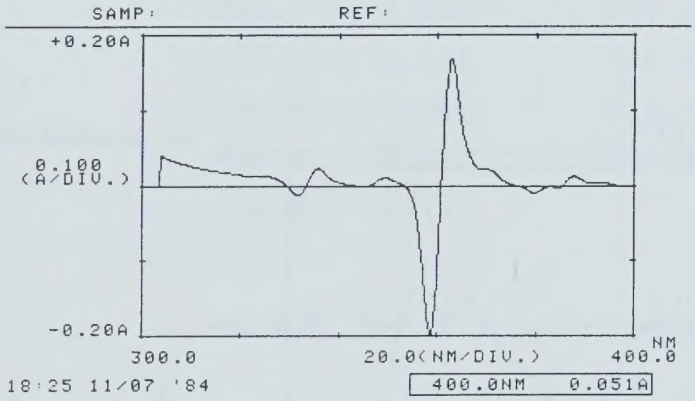
(a) Original spectrum



(b) First-order derivative

$\Delta\lambda = 0.8$ nm

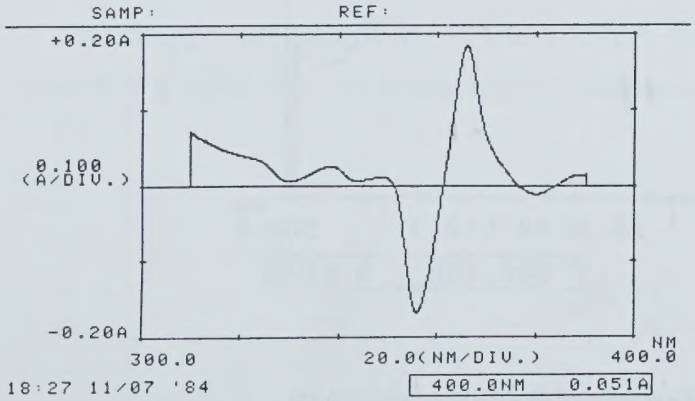
(N=1)



(c) First-order derivative

$\Delta\lambda = 2.4$ nm

(N=3)



(d) First-order derivative

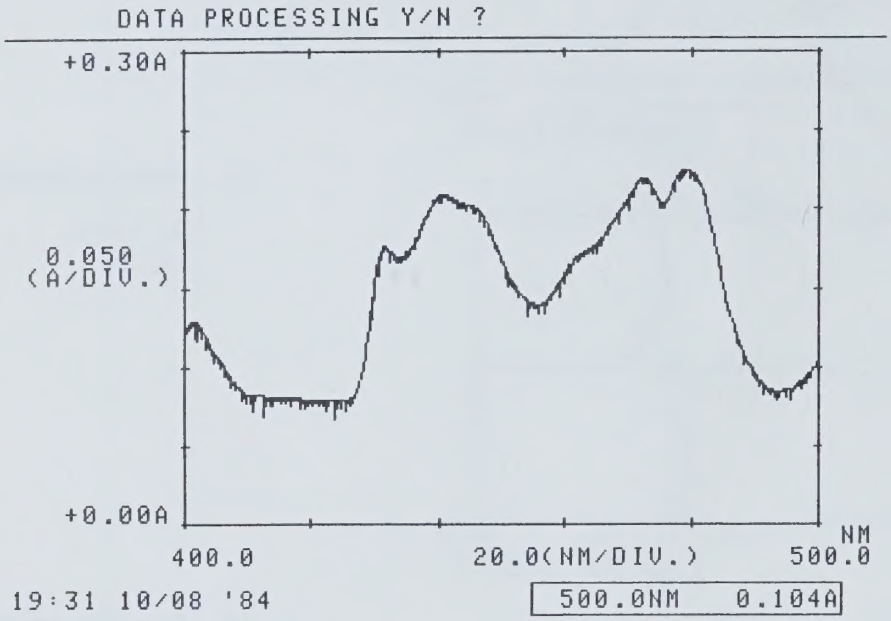
$\Delta\lambda = 6.4$ nm

(N=8)

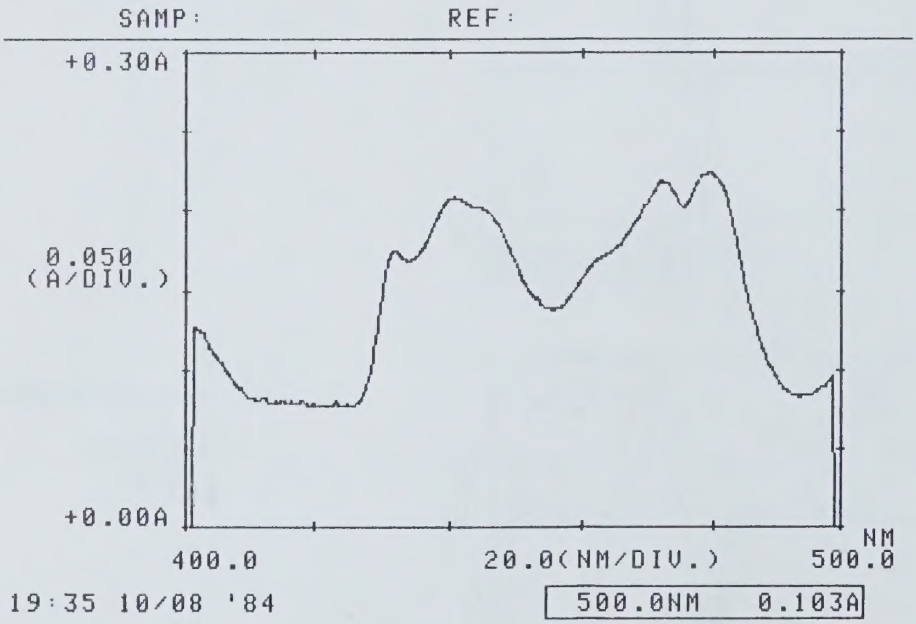
Fig. 4.16 Changes of the Derivative Spectrum with Changing $\Delta\lambda$

(5) Smoothing

A measured spectrum can be smoothed in this processing. The smoothing routine uses 17 data points to perform its smoothing. The processing method is similar to that of differentiation. Fig. 4.17 shows an example of smoothed spectrum.



(a) **Original spectrum**



(b) **Smoothed spectrum**

Fig. 4.17 Example of Spectrum Smoothing

(6) Data Print-out at Regular Wavelength Intervals

The values of a measured spectrum are printed out at regular wavelength intervals. The wavelength interval is chosen within the range of 1 ~ 99nm. Fig. 4.18 shows an example of this processing using a wavelength interval of 20nm.

*** DATA PRINT ***

λ	ABS	λ	ABS
800.0	0.627	780.0	0.110
760.0	0.227	740.0	0.758
720.0	0.048	700.0	0.043
680.0	0.078	660.0	0.039
640.0	0.042	620.0	0.048
600.0	0.367	580.0	0.928
560.0	0.068	540.0	0.117
520.0	0.186	500.0	0.094
480.0	0.215	460.0	0.148
440.0	0.197	420.0	0.070
400.0	0.112		

Fig. 4.18 Print-out at Regular Wavelength Intervals

(7) Outputting to plotter

With the optional color plotter (P/N 206-15788) for the UV-160A, spectrum data can be plotted in 6 colors. For the details, refer to its instruction manual.

4.4.2 Operation

When the system enters the SPECTRUM mode, the following display appears on the CRT (Fig. 4.19). A description of each parameter is described in Table 4.5.

```
SPECTRUM        PARAMETER CHANGE Y/N ?

        1.λS= 800.0NM     λE= 400.0NM
        2.MEASURE(ABS/T%)=ABS
        3.UPPER=+2.00A     LOWER=+0.00A
        4.SCAN SPEED=FAST
        5.CYCLE      T=  60SEC  N= 1
        6.OVERLAY            NO
        7.COPY               NO
        8.SURVEY SCAN        NO
        9.FILE

21:13  2/04 '85                  800.0NM    0.001A
```

Fig. 4.19 Parameter Changing Display in the SPECTRUM Mode

Table 4.5 Description of the Analytical Parameters in the SPECTRUM Mode

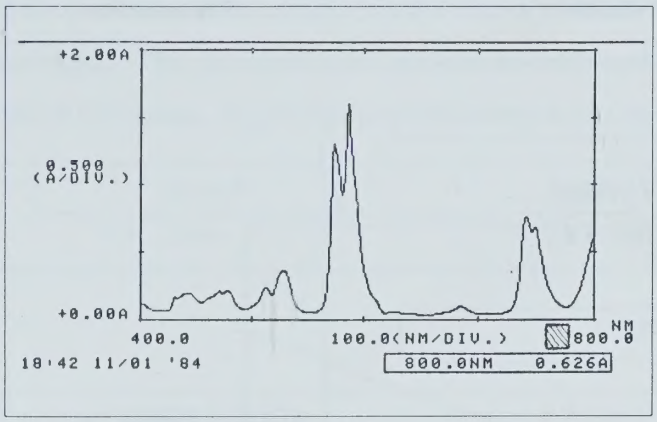
Item [Valid range]	Description
1. λ_S, λ_E [200 ~ 1100] ($\lambda_S - \lambda_E \geq 10$)	Means the starting wavelength λ_S and ending wavelength λ_E. The minimum wavelength range is 10nm.
2. MEASURE [ABS, T%]	Used to select the measuring mode ABS or T%.
3. UPPER, LOWER ABS [-2.5 ~ 2.5] (UPPER - LOWER ≥ +0.01) T% [-125 ~ 125] (UPPER - LOWER ≥ +1)	Used to set the ordinate full scale range defined by UPPER and LOWER. The increment is 0.01 Abs. (or 1T%).
4. SCAN SPEED [FAST, MED, SLOW]	Used to set the wavelength scanning speed to FAST, MED, or SLOW.
5. CYCLE T [0 – 9999] CYCLE N [1 – 99]	Parameters for repeated measurements. The cycle time T (in sec) is defined as a period from the time when a measurement starts till the time when the next measurement starts. If the measuring time is longer than T, the next measurement starts immediately. N indicates the repetition No. Set N = 1 for a single measurement (without repetition).
6. OVERLAY [YES, NO]	Used to select the recording mode, overlapped recording (YES) or not (NO).
7. COPY [YES, NO]	Used to select whether a measured spectrum is to be copied automatically after measurement or not (YES or NO).
8. SURVEY SCAN	Used to select the fastest scan rate for a given scan speed.
9. FILE	To be selected for filing (file storage).

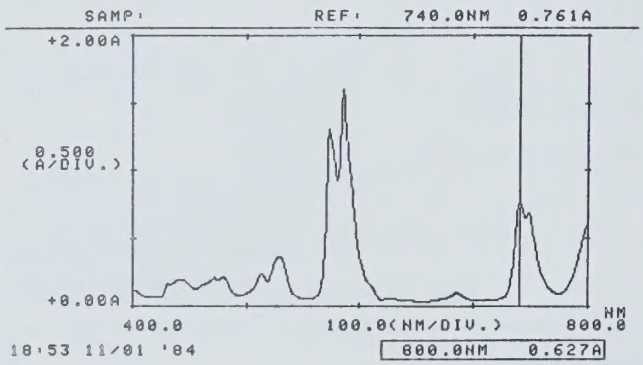
ATTENTION

Data processing can not be applied to spectra which are measured in the repeated scan mode.

Operating procedure:

Step	Operation & CRT display	Key operation	Next step
1	Select mode No. 2 (SPECTRUM).	MODE 2 ENTER	
2	SPECTRUM PARAMETER CHANGE Y/N ? 1.λS= 800.0NM λE= 400.0NM 2.MEASURE(ABS/T%)=ABS 3.UPPER=+2.00A LOWER=+0.00A 4.SCAN SPEED=FAST 5.CYCLE T= 60SEC N= 1 6.OVERLAY NO 7.COPY NO 8.SURVEY SCAN NO 9.FILE		
3	Set the analytical parameters.	Refer to 4.2.1.	
4	Start a measurement.	START/STOP	
5	DATA PROCESSING Y/N ?		
6	If data processing is to be made: If data processing is not to be made:	YES NO	8 7
7	If the next measurement is to be made: …… If the next measurement is not to be made: ……		4 25
8	1)SAVE 2)EXP. 3)PEAK 4)DERIV. 5)PRINT 6)PLOT No.=		
9	Select the desired processing mode: For data storage (saving) For expansion/compression For peak detection For differentiation/smoothing For data print-out at regular wavelength intervals For outputting to plotter	 1 ENTER 2 〃 3 〃 4 〃 5 〃 6 〃 (To plotter routine if plotter is connected.) →	 10 12 16 17 22
10	SAVE CHANNEL NO. ? (1, 2) "□"		
11	Select channel CH1 or CH2. Then, the data is saved immediately.	1 or 2 ENTER	5

Step	Operation & CRT display	Key operation	Next step
12			
13	Enter the desired value for the flashing cursor position. Only press the ENTER key if the present value is acceptable. After all entries are finished, a new spectrum is immediately displayed.	[Value] [ENTER] 〃 〃 〃 〃 〃 〃	
14	RETURN TO ORIGINAL CURVE Y/N ?		
15	If the system is to be returned to the original spectrum: If the system is not to be returned to the original spectrum:	[YES] [NO] (When [NO] is pressed, the original spectrum is lost and the new "original" spectrum is the one currently on the CRT.)	5 5
16	The peaks and valleys on the spectrum are marked. At the same time, their wavelengths and measured values are printed out on the printer.		5
17	DERIVATIVE ORDER ? (0−4) "□"		
18	Enter the order of the derivative spectrum; 0 for smoothing.	[0] ~ [4] [ENTER]	
19	dλ(N), dT(N) N=? (1−9) " " For the relation between N and Δλ (dλ), refer to Table 4.4. If a differentiation is made for an expanded or compressed spectrum (with the wavelength range changed), Δλ should correspond to the original (measured) wavelength range.	[1] ~ [9] [ENTER]	

Step	Operation & CRT display	Key operation	Next step
20	PROCESSING		
21	Wait for a while until the processing is finished. Then, the result will be indicated on the CRT.		14
22	PRINT OUT INTERVAL ? " " NM		
23	Set the wavelength interval.	Value ENTER [1～99]	
24	Data is printed out on the printer.	To stop the printing, press the START/STOP key.	5
25	 When ⇦ and ⇨ keys are pressed, a cursor appears on the CRT and the wavelength and measured value corresponding to the cursor position are indicated in the upper right side of the screen.		
26	End. The next measurement can be started by pressing the START/STOP key (go to Step 4). When the RETURN key is pressed, the system returns to Step 2. And then, when the MODE key is pressed, the mode menu appears on the CRT.		

4.5 TIME SCAN mode

This mode is used to measure a time-course variation of absorbance or transmittance at a fixed wavelength. The measured curve can also be processed similar to spectra acquired in the SPECTRUM mode. Fig. 4.20 shows an example of a measurement in this mode.

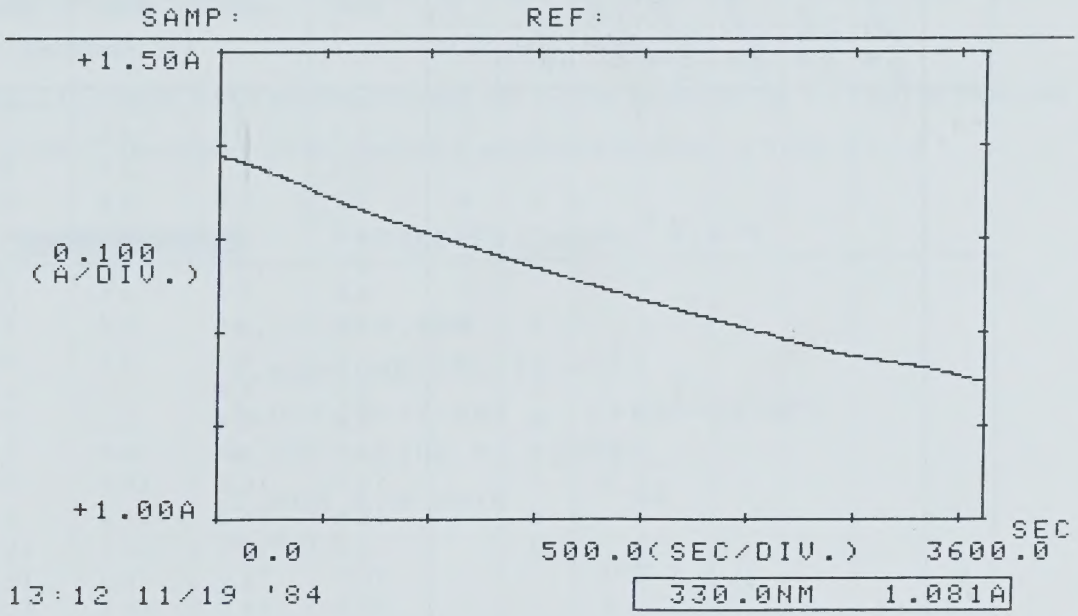


Fig. 4.20 Example of a Measurement in the Time Scan Mode

4.5.1 Processings for a Time Course Curve

(1) Saving: This processing is literally the same as (1) in Section 4.4.1 except that the abscissa axis is in time and not wavelength.

(2) Expansion/compression: This processing is literally the same as (2) in Section 4.4.1 except that the abscissa axis is in time.

(3) Peak detection: This processing is literally the same as (3) in Section 4.4.1 except that the abscissa axis is in time. Table 4.6 shows the relation between RECORDING TIME (sec.) and data sampling interval (sec.).

Table 4.6 Relation Between the RECORDING TIME and the Sampling Interval

RECORDING T (sec)	Data sampling interval (sec)
6000 ≧ T > 5000	10
5000 ≧ T > 2000	5
2000 ≧ T > 1000	2
1000 ≧ T > 500	1
500 ≧ T > 200	0.5
200 ≧ T > 100	0.2
100 ≧ T ≧ 10	0.1

(4) Differentiation: Refer to (4) in Section 4.4.1. Table 4.7 shows the relation between RECORDING TIME, key entry N, and the derivative time difference Δt.

Table 4.7 Relation Among the RECORDING TIME, Key Entry N and Δt

	RECORDING TIME (sec)							Δt (SEC)			
	6000≦T<5000	5000≦T<2000	2000≦T<1000	1000≦T<500	500≦T<200	200≦T<100	100≦T≦10	1st order	2nd order	3rd order	4th order
							1	0.8	0.7	0.7	0.6
						1	2	1.6	1.4	1.4	1.2
							3	2.4	2.1	2.1	1.8
						2	4	3.2	2.8	2.8	2.4
					1		5	4.0	3.5	3.5	3.0
						3	6	4.8	4.2	4.2	3.6
							7	5.6	4.9	4.9	4.2
						4	8	6.4	5.6	5.6	4.8
							9	7.2	6.3	6.3	5.4
				1	2	5		8.0	7.0	7.0	6.0
						6		9.6	8.4	8.4	7.2
						7		11.2	9.8	9.8	8.4
					3			12.0	10.5	10.5	9.0
						8		12.8	11.2	11.2	9.6
						9		14.4	12.6	12.6	10.8
N			1	2	4			16.0	14.0	14.0	12.0
					5			20.0	17.5	17.5	15.0
				3	6			24.0	21.0	21.0	18.0
					7			28.0	24.5	24.5	21.0
			2	4	8			32.0	28.0	28.0	24.0
					9			36.0	31.5	31.5	27.0
		1		5				40.0	35.0	35.0	30.0
			3	6				48.0	42.0	42.0	36.0
				7				56.0	49.0	49.0	42.0
			4	8				64.0	56.0	56.0	48.0
				9				72.0	63.0	63.0	54.0
	1	2	5					80.0	70.0	70.0	60.0
			6					96.0	84.0	84.0	72.0
			7					112.0	98.0	98.0	84.0
		3						120.0	105.0	105.0	90.0
			8					128.0	112.0	112.0	96.0
			9					144.0	126.0	126.0	112.0
	2	4						160.0	140.0	140.0	120.0
		5						200.0	175.0	175.0	150.0
	3	6						240.0	210.0	210.0	180.0
		7						280.0	245.0	245.0	210.0
	4	8						320.0	280.0	280.0	240.0
		9						360.0	315.0	315.0	270.0
	5							400.0	350.0	350.0	300.0
	6							480.0	420.0	420.0	360.0
	7							560.0	490.0	490.0	420.0
	8							640.0	560.0	560.0	480.0
	9							720.0	630.0	630.0	540.0

(5) Smoothing: This processing is literally the same as (5) in Section 4.4.1 except that the abscissa axis is in time.

(6) Data print-out at regular intervals: This processing is literally the same as (6) in Section 4.4.1 except that the abscissa axis is in time.

(7) Outputting to plotter: The same as (7) in 4.4.1, except that the abscissa axis is in time.

4.5.2 Operation

When the TIME SCAN mode is selected, the display shown in Fig. 4.21 will be indicated on the CRT. Description of the analytical parameters is shown in Table 4.8.

```
TIME SCAN        PARAMETER CHANGE Y/N ?

1.λ= 800.0NM
2.MEASURE(ABS/T%)=ABS
3.UPPER=+2.00A     LOWER=+0.00A
4.RECORDING T=  60SEC
5.ABS X10 GAIN       NO
6.FILE

19:00 11/01 '84                    800.0NM   0.627A
```

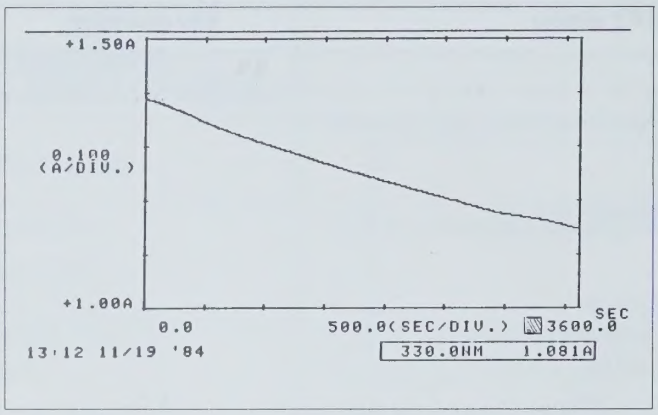
Fig. 4.21 Parameter Changing Display in the TIME SCAN mode

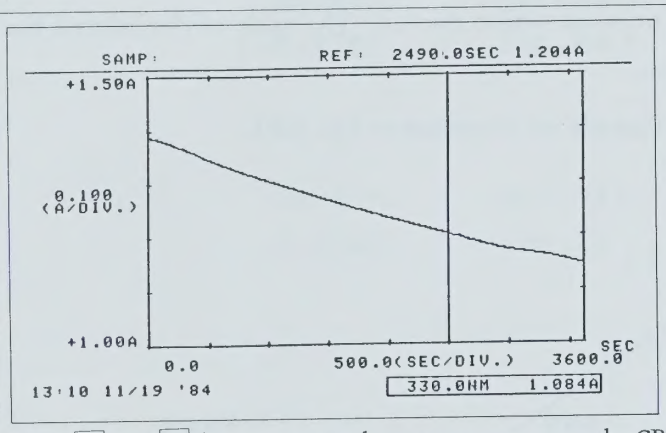
Table 4.8 Description of the Analytical Parameters in the TIME SCAN Mode

Item [Valid entries]	Description
1. λ [200 ~ 1100]	Means the measuring wavelength.
2. MEASURE [ABS, T%]	Used to select the measuring mode, absorbance (ABS) or transmittance (T%).
3. UPPER, LOWER ABS. [-2.5 ~ 2.5] UPPER - LOWER ≧ +0.01 T% [-125 ~ 125] UPPER - LOWER ≧ +1	Used to set the measuring range defined by UPPER and LOWER. The increment is 0.01 Abs. or 1%T. If parameter No. 5 (ABS × 10 GAIN) is set to YES, both UPPER and LOWER settings in Abs. decrease automatically to 1/10 of their set values (e.g. 2.0 ~ -1.0 → 0.2 ~ -0.1).
4 RECORDING T [10 ~ 6000]	Means the measuring time.
5. ABS × 10 GAIN [YES, NO]	If this parameter is set to YES, the measuring sensitivity in Abs. increases by a factor of 10 with an ordinate increment of 0.001 Abs. The initial output is always zero because auto zeroing is performed immediately after a measurement starts. Additionally, the maximum measuring range becomes nearly 0.25 ~ -0.25 Abs. When the measurement is finished, auto zeroing is automatically cancelled and photometric display returns to the normal display. Note that if this parameter is set to NO, auto zeroing is not performed.
6. FILE	To be selected for filling (file saving).

Operating procedure:

Step	Operation & CRT display	Key operation	Next step
1	Select mode 3 (TIME SCAN).	MODE 3 ENTER	
2	TIME SCAN PARAMETER CHANGE Y/N ? 1.λ= 800.0NM 2.MEASURE(ABS/T%)=ABS 3.UPPER=+2.00A LOWER=+0.00A 4.RECORDING T= 60SEC 5.ABS X10 GAIN NO 6.FILE		
3	Set the analytical parameters	Refer to 4.2.1.	
4	Start a measurement	START/STOP	
5	DATA PROCESSING Y/N ?		
6	If data processing is to be made: If data processing is not to be made:	YES NO	8 7
7	If the next measurement is to be made: ..... If the next measurement is not to be made:		4 25
8	1)SAVE 2)EXP. 3)PEAK 4)DERIV. 5)PRINT 6)PLOT No.=		
9	Select the desired processing mode: For data saving (storage) For expansion/compression For peak detection For differentiation/smoothing For data print-out at regular intervals For outputting to plotter	 1 ENTER 2 ENTER 3 ENTER 4 ENTER 5 ENTER 6 ENTER (To plotter routine if plotter is connected.) →	 10 12 16 17 22
10	SAVE CHANNEL NO. ? (1, 2) " "		
11	Select the saving channel CH1 or CH2. Then, data is saved immediately.	1 or 2 ENTER	5

Step	Operation & CRT display	Key operation	Next step
12			
13	Enter the desired value for the flashing cursor position. Only press the [ENTER] key if the present value is acceptable. After all the entries are finished, the new spectrum is immediately displayed.	[Value] [ENTER] [Value] [ENTER] [Value] [ENTER] [Value] [ENTER]	
14	RETURN TO ORIGINAL CURVE Y/N ?		
15	If the system is to be returned to the original spectrum: If the system is not to be returned to the original spectrum:	[YES] [NO] (When [NO] is pressed the original spectrum is lost and the new "original" spectrum is the one currently on the CRT.)	5 5
16	The peaks and valleys on the spectrum are marked. At the same time, their times and measured values are printed out on the printer.		5
17	DERIVATIVE ORDER ? (0–4) " "		
18	Enter the order of the derivative spectrum; 0 for smoothing.	[0] ~ [4] [ENTER]	
19	dλ(N), dT(N) N=? (1–9) " " For the relation between N and dT (Δt), refer to Table 4.7. If a differentiation is made for an expanded or compressed spectrum (with the measuring time changed), Δt should correspond to the original measuring time.	[1] ~ [9] [ENTER]	
20	PROCESSING		

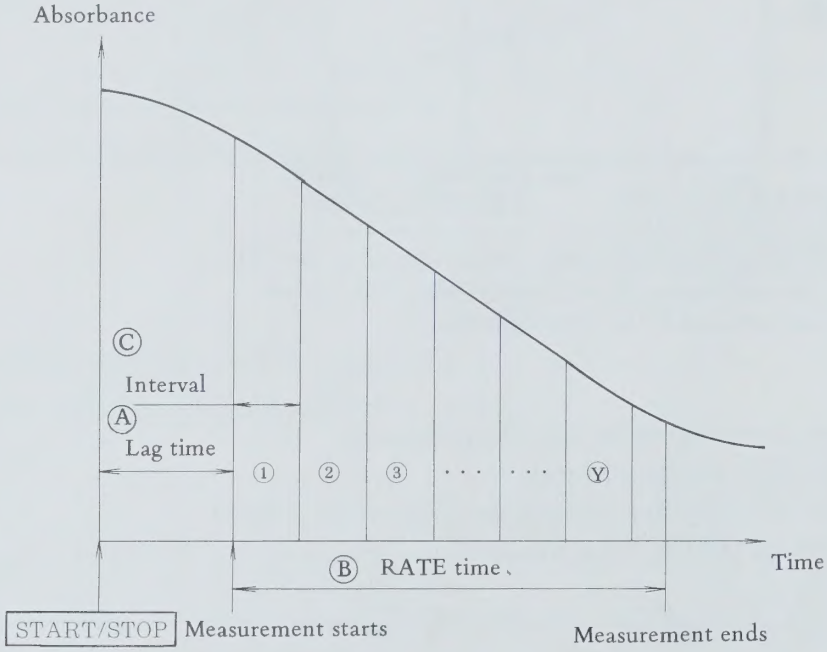
Step	Operation & CRT display	Key operation	Next step
21	Wait until the processing is finished. Then, the result will be indicated on the CRT.		14
22	PRINT OUT INTERVAL ? “ ” SEC		
23	Set the time interval.	Value ENTER [1～99]	
24	Data is printed out on the printer.	To stop the printing, press the START/STOP key.	5
25	 When ⇦ and ⇨ keys are pressed, a cursor appears on the CRT and the time and measured value corresponding to the cursor position are indicated in the upper right side.		
26	End. The next measurement can be started by pressing the START/STOP key (go to Step 4). When the RETURN key is pressed, the system returns to Step 2. Then when the MODE key is pressed, the basic mode menu appears on the CRT.		

4.6 KINETIC Mode

In this mode, the time-course variation of absorbance (reaction curve) is indicated on the CRT and at the same time, the absorbances and absorbance changes are obtained. Then, the absorbance change rate during the RATE time is obtained by the 20-point least-squares method. Less than 20 points will be used if the (data acquisition rate) × 20 is greater than the RATE time. In such a case, the number of points used will be equal to the maximum number N which meets the equation [(data acquisition rate) × N ≦ (RATE TIME)]. The absorbance change rate value multiplied by a user specified FACTOR is output as the activity value. In a post-run manner, the LAG TIME and RATE measuring time can be changed. The new calculation results will be in accordance with the new LAG TIME and RATE measuring time values. The only restriction is that the new total time (LAG TIME + RATE measuring time) must not be greater than the original total time.

Note: The purpose of entering an interval is strictly for convenience. It allows the user to observe the absorbance change on the printout within the run. The value of the interval has no effect on the activity calculation.

The terms used in the KINETIC mode are described in Fig. 4.22.



Ⓐ Lag time (LAG T): Means the period from the time when the START/STOP key is pressed till the time when a measurement starts.

Ⓑ Rate time (RATE T): The activity value is obtained from the data measured during this period. More specifically, a regression line is obtained from the data acquired at equally spaced points during the RATE time. Then, its slope (Δ Abs/min) is multiplied by a user-specified FACTOR to obtain the activity value.

Ⓒ Interval: That time segment whereby the absorbance change is calculated from the absorbances at the begining and end of this segment.

Ⓓ FACTOR: Absorbance change rate (Δ Abs/min) multiplied by FACTOR is equal to the activity value.

Fig. 4.22 Terms Used in the KINETIC MODE

Fig. 4.23 shows an example of the results from a KINETIC mode measurement.

```
                    ***  KINETIC  ***

     No.      T(SEC)      ABS          dA
-----------------------------------------
       1      180        -.1181
              240        -.1480      -.0299
              300        -.1774      -.0293

    LAG T= 180SEC     RATE T= 120SEC

     dA/MIN.       ACTIVITY
    -0.0301        100.44

    LAG T= 150SEC     RATE T= 150SEC

     dA/MIN.       ACTIVITY
    -0.0302        100.79
```

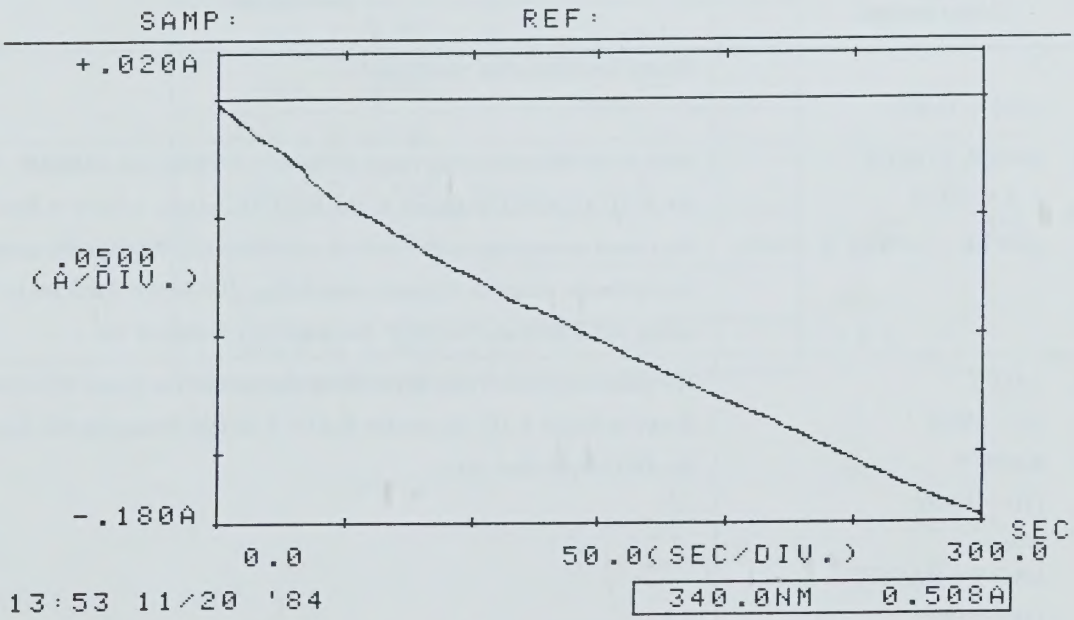


Fig. 4.23 The Results from a KINETIC Mode Measurement

When the KINETIC mode is selected, the display shown in Fig. 4.24 is indicated on the CRT. A description of the analytical parameters is given in Table 4.9.

```
KINETIC          PARAMETER CHANGE Y/N ?

        1.λ= 800.0NM
        2.UPPER=+2.00A     LOWER=+0.00A
        3.LAG T=  10SEC     RATE T=  50SEC
          INTERVAL T=  10SEC
        4.FACTOR= 1.0000
        5.SAMPLE No.=   1
        6.GAIN X10          NO
        7.FILE

19:47 11/01 '84                  800.0NM   0.000A
```

Fig. 4.24 Parameter Changing Display in the KINETIC Mode

Table 4.9 Description of the Analytical Parameters in the KINETIC Mode

Item [Valid entries]	Description
1. λ [200 ~ 1100]	Means the measuring wavelength.
2. UPPER, LOWER [-2.5 ~ 2.5] (UPPER - LOWER ≧ +0.01)	Used to set the measuring range defined by UPPER and LOWER. Because of the AUTO RANGE program in the KINETIC mode, a curve is first measured in the preset measuring range. It then automatically displays the same curve using the optimum range to enhance readability. If GAIN X 10 is set to YES, the values of UPPER and LOWER decrease by a factor of 10.
3. LAG T [0 ~ 4800] RATE T [10 ~ 6000] Where LAG T + RATE T [10 ~ 6000] INTERVAL [Sampling interval ~ RATE T]	The data acquisition rate depends on the sum of the (LAG T) + (RATE T) as shown in Table 4.10. So set the RATE T so that it may be much greater than the data acquisition rate. Set a value between the data acquisition rate and the RATE T.

Item [Valid entries]	Description
4. FACTOR [0.0001 ~ 9999.9] Zero and negative entries valid	Used to multiply the absorbance change rate to obtain the activity value.
5. SAMPLE NO. [0 ~ 9999]	Means the sample No. It increases by one automatically after each measurement.
6. GAIN × 10 [YES, NO]	If this parameter is set to YES, the measuring sensitivity increases by a factor of 10 with an ordinate increment of 0.001 Abs. The initial output is always zero because auto zeroing is performed immediately after a measurement starts. Additionally, the maximum measuring range becomes nearly 0.25 ~ -0.25 Abs. When the measurement is finished, auto zeroing is automatically cancelled and the photometric display returns to the normal display. Note that if this parameter is set to NO, auto zeroing is not performed.
7. FILE	To be selected for filing (file saving).

Table 4.10 Relation Between the (LAG T) + (RATE T) and the Data Acquisition Rate

(LAG T) + (RATE T) (sec)	Data acquisition rate (sec)
$10 \leqq T \leqq 100$	0.1
$100 < T \leqq 200$	0.2
$200 < T \leqq 500$	0.5
$500 < T \leqq 1000$	1
$1000 < T \leqq 2000$	2
$2000 < T \leqq 5000$	5
$5000 < T \leqq 6000$	10

Operating procedure:

Step	Operation & CRT display	Key operation	Next step
1	Select mode No. 4 (KINETIC).	MODE 4 ENTER	
2	KINETIC PARAMETER CHANGE Y/N ? 1.λ= 800.0NM 2.UPPER=+2.00A LOWER=+0.00A 3.LAG T= 10SEC RATE T= 50SEC INTERVAL T= 10SEC 4.FACTOR= 1.0000 5.SAMPLE No.= 1 6.GAIN X10 NO 7.FILE		
3	Set the analytical parameters.	Refer to Section 4.2.1.	
4	Start a measurement.	START/STOP	
5	A time-course curve of absorbance is displayed. Absorbances, absorbance changes, and activity values are printed out at regular time intervals.		
6	CHANGE TIME Y/N ?		
7	If the RATE measuring time is to be changed: If the RATE measuring time is not to be changed:	YES NO	8 11
8	LAG T= RATE T=		
9	Enter LAG time and RATE time.	Value ENTER Value ENTER	
10	Absorbance change rates and activity values for the new RATE measuring time are printed out.		6
11	End. The next measurement can be started by pressing the START/STOP key (go to Step 4). When the RETURN key is pressed, the system returns to Step 2. Then when the MODE key is pressed, the mode menu is displayed on the CRT.		

4.7 Quantitative Measurement Mode (QUANTITATIVE)

This mode is used to determine the concentration of an unknown sample with the use of a working curve which is pre-calibrated with standard samples. For the working curve calibration and the determination of unknown sample concentration, any of the results of the one-wavelength determination method, two-wavelength determination method, three-wavelength determination method, or derivative determination (differentiation) method can be used. Except for $C = K * A + B$ method, either the linear or polygonal regression lines for any method can be chosen as the working curve. In addition, repeated measurements can be made to use their average in calibrating the working curve, or in determining the concentration of unknown samples.

In the case of a linear working curve ($C = K \cdot A + B$), its coefficients K and B can be entered through the keyboard if they are known.

4.7.1 Various Methods for Quantitative Measurements

(1) 1λ Method

Unknown sample concentrations can be determined from a linear or non-linear working curve that the operator constructs. The operator may construct either a linear or non-linear working curve in one of 2 ways: (1) manually enter the known standard concentrations AND standard absorbances or (2) manually enter the known standard concentrations and then measure the absorbance values of the standards.

Fig. 4.25 shows an example of a linear working curve and concentration results using the 1λ method in the Quantitative Mode. Fig. 4.25a shows an example of a non-linear working curve and concentration results using the 1λ method in the Quantitative Mode.

(2) Two-Wavelength/Three-Wavelength Determination Methods

If there is a rise in the baseline due to the effect of interfering components or due to scattering caused by turbidity or small bubbles, the two-wavelength/three-wavelength determination can be effectively used to eliminate these obstructive effects. For the two-wavelength/three-wavelength determination, refer to Section 4.3.1.

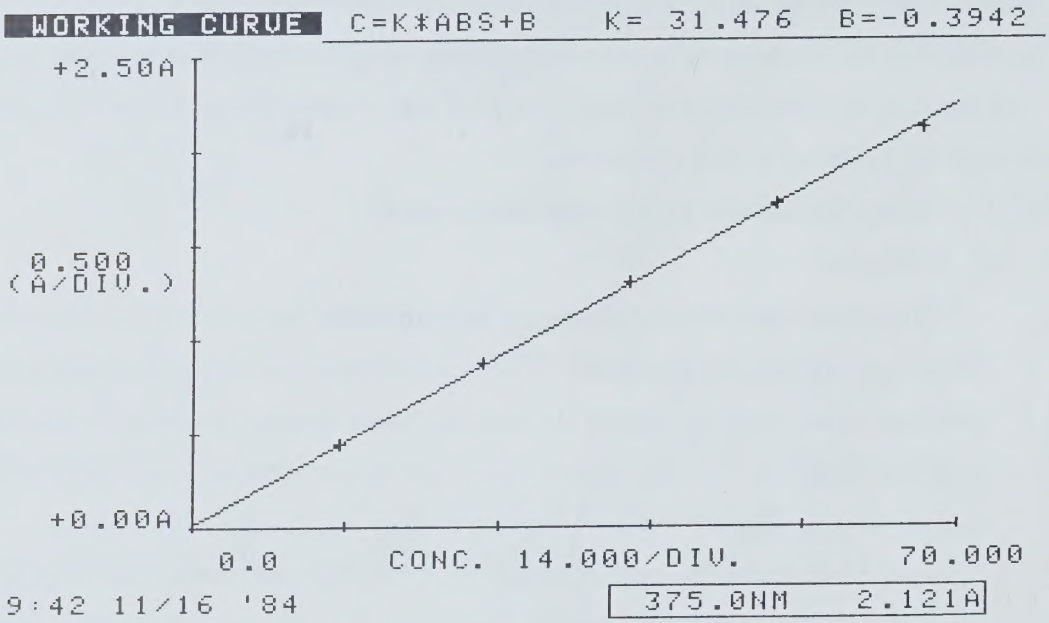
(3) Derivative Determination (Differentiation) Method

This method can be used for quantitative measurements with derivative values. The working curve calibration and the determination of unknown sample concentration can be made with the 1st-to the 4th-order derivative values. The derivative value is obtained by automatic wavelength scanning around each wavelength. For the derivative determination (differentiation), refer to Section 4.4.1. To determine the Δλ (nm) used for differentiation, refer to Table 4.4.

Note: With respect to Table 4.4, the derivative determination method used in the Quantitative Measurement Mode ALWAYS uses a Δλ (nm) corresponding to a measuring wavelength range of less than or equal to 100nm.

(4) C = K * A + B Method (Manual Input of Working Curve Coefficients)

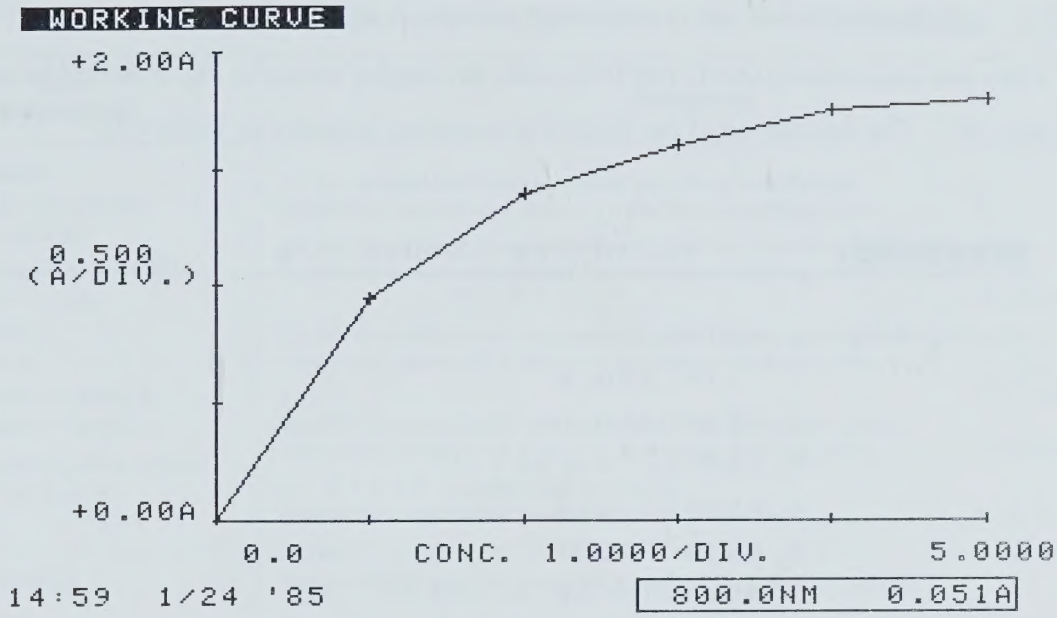
Unknown sample concentrations can be directly determined when the coefficients of the working curve are entered through the keyboard if they are known. Only a linear working curve of the type C = K·A + B (where K is the slope, and B is the intercept) can be entered via the keyboard. Fig. 4.25b shows an example of the results of a quantitative measurement using the C = K * A + B method.



** QUANTITATIVE ANALYSIS **

No.	ABS.	CONC.
1	1.258	39.228
2	0.791	24.535
3	1.019	31.697
4	1.707	53.337

Fig. 4.25 Example Results of a Quantitative Measurement using the 1λ Method (linear calibration)



** QUANTITATIVE ANALYSIS **

No.	ABS.	CONC.
1	0.051	0.0545
2	0.668	0.7042
3	0.742	0.7813
4	0.559	0.5891

Fig. 4.25a Example Results of a Quantitative Measurement using the 1λ Method (Non-linear calibration)

** QUANTITATIVE ANALYSIS **

No.	ABS.	CONC.
1	0.003	0.0041
2	0.668	0.7042
3	0.051	0.0545

Fig. 4.25b Example Results of a Quantitative Measurement using the C = K * A + B Method.

4.7.2 Operation

When you select the QUANTITATIVE mode, the display shown in Fig. 4.26 will be indicated on the CRT. The description of the analytical parameter is shown in Table 4.11.

```
QUANT.          PARAMETER CHANGE Y/N ?

        1.METHOD:1λ
           λ1= 800.0
        2.STANDARD N= 5
        3.SAMPLE No.=    1
        4.REPEAT N=1
        5.DATA PRINT            NO
        6.NON-LINEAR W.CURVE    NO
        7.FILE

13:55  9/04 '87                 800.0NM    0.000A
```

Fig. 4.26 Parameter Changing Display in the QUANTITATIVE Mode

Table 4.11 Description of the Analytical Parameters in the Quantitative Mode

Item [Valid entries]	Description
1. METHOD [1λ, 2λ, 3λ, dA/dλ, C = K*A + B] $\lambda_1 \sim \lambda_3$ [200 ~ 1100] λ[200 ~ 1100] ORDER [1 ~ 4] N[1 ~ 9] K[0.0001 ~ 9999.9] B[0.0001 ~ 9999.9] Zero and negative entries valid for K & B	1λ for quantitative measurement at a fixed wavelength (operator constructed linear or non-linear working curve) . . . . . λ_1 2λ for quantitative measurement by the two-wavelength determination (operator constructed linear or non-linear working curve) . . . . . λ_1, λ_2 $(\lambda_1 > \lambda_2)$ 3λ for quantitative measurement by the three-wavelength determination (operator constructed linear or non-linear working curve) . . . . . $\lambda_1, \lambda_2, \lambda_3$ $(\lambda_1 > \lambda_2 > \lambda_3)$ dA/dλ for quantitative measurement with derivative values (operator constructed linear or non-linear working curve) . . . . . λ, ORDER, N C = K * A + B for inputting coeffients (operator constructed linear working curve only) . . . . . K, B, λ
2. STANDARD [2 ~ 20]	Means the number of standard samples. You do not set this parameter in the C = K * A + B Method.
3. SAMPLE NO. [0 ~ 9999]	Means the sample No. which increases automatically by one after each measurement.
4. REPEAT [1 ~ 9]	Means the number of repeated measurements. Independently selectable for calibration and the measurement of unknown samples. The average of all repeated measurements is used as data. If RETURN key is pressed during repetition, the last measurement is used as data.
5. DATA PRINT [YES, NO]	When this parameter is set to YES, the result of the measurement is indicated on both the CRT and the printer. When it is set to NO, the results is indicated only on the CRT.
6. NON-LINEAR W. CURVE [YES, NO]	When this parameter is set to YES, the working curve becomes polygonal (non-linear). When it is set to NO, the working curve becomes linear. (The non-linear working curve cannot be used with the C = K * A + B Method)
7. FILE	To be selected for filing. In this case, a file contains the analytical parameters and working curve. Selection of this parameter is rejected if there is no working curve. 20 linear working curves or 6 non-linear working curves can be saved. However, if a file of multi-component determination has already been saved, any non-linear working curve cannot be saved.

ATTENTION

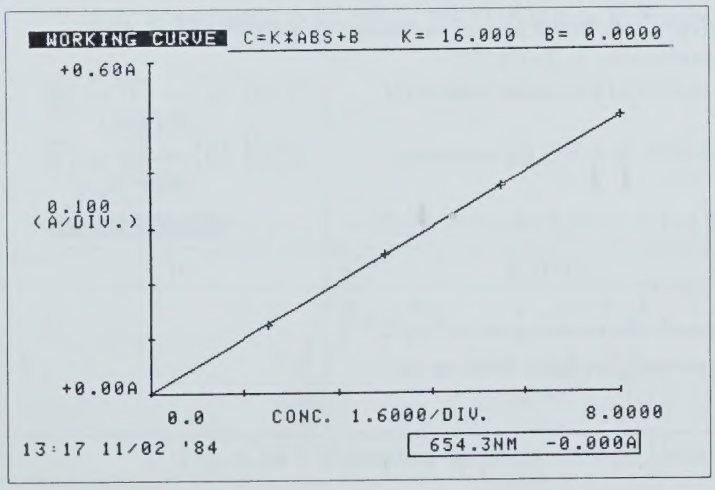
If you desire, make a hard copy of the CRT screen by depressing the COPY key after setting the working curve and displaying it on the CRT.

This suggestion is made because the working curve cannot be displayed on the CRT once you start measuring unknown samples.

To display the working curve again, recall the parameter changing display. Then file the parameters with the working curve. When the file is recalled again, the working curve is displayed on the CRT. But when the method is the C = K * A + B method, the working curve is not displayed.

Operating procedure:

Step	Operation & CRT display	Key operation	Next step
1	Select mode No. 5 (QUANTITATIVE).	MODE 5 ENTER	
2	QUANT. PARAMETER CHANGE Y/N ? 1.METHOD:1λ λ1= 800.0 2.STANDARD N= 5 3.SAMPLE No.= 1 4.REPEAT N=1 5.DATA PRINT NO 6.NON-LINEAR W.CURVE NO 7.FILE		
3	Set the analytical parameters	Refer to Section 4.2.1.	
4	If the method selected is C = K*A + B: ····· If the method selected is not C = K*A + B: ·····		25 5
5	CALIBRATION STD. No. 1 CONC.= 0.0000 STD. No. CONC. ABS. 1 2 3 4 5		
6	Enter all standard sample concentrations **in increasing order.** (max. 20) * Do not use same concentration standards for the non-linear working curve which is not made by means of the least-squares method.	Value ENTER ⋮ ⋮ [0.0001~9999.9]	
7	CHANGE CONC Y/N?		
8	If any of the entries of the standard sample concentrations are to be changed: If entries of the standard sample concentrations are not to be changed:	YES NO	9 10
9	Enter a standard sample No. to be changed and its correct concentration.	Value ENTER Value ENTER	7
10	ABS. DATA MANUAL INPUT Y/N ?		
11	If standard absorbance data is to be manually entered: If standard absorbance data is not to be manually entered:	YES NO	12 17
12	STD. NO. 01 ABS.=0.0000		

Step	Operation & CRT display	Key operation	Next step
13	Manually enter all standard sample absorbances. (max. 20)	Value ENTER ⋮ ⋮ [−2.5 ~ 2.5]	
14	CHANGE DATA Y/N ?		
15	If any of the standard absorbance entries are to be changed: If the standard absorbance entries are not to be changed:	YES NO	16 19
16	Manually enter a standard sample No. to be changed and its correct absorbance.	Value ENTER Value ENTER	14
17	SET STD. NO. 01 PRESS START KEY		
18	Insert standard samples and measure them one after another.	START / STOP ⋮	
19	WORKING CURVE DISPLAY Y/N ?		
20	If the working curve is to be displayed on the CRT: If the working curve is not to be displayed on CRT:	YES NO	21 25
21	WORKING CURVE CONC. MAX CHANGE Y/N ?		
22	If the upper limit on the concentration axis is to be changed: If the upper limit on the concentration axis is not to be changed:	YES NO	23 24
23	Manually enter a new upper limit.	Value ENTER [Max. conc. ~ 9999.9]	21
24			

Step	Operation & CRT display	Key operation	Next step
25	To start a measurement after inserting an unknown sample: To return to the Parameter Changing Display: To terminate the measurement:	[START/STOP] [RETURN]	26 27 33
26	QUANT. SET SAMPLE, PRESS START KEY No. ABS. CONC. 1 0.572 9.1563		25
27	QUANT. PARAMETER CHANGE Y/N ? 1.METHOD:1λ λ1= 800.0 2.STANDARD N= 5 3.SAMPLE No.= 1 4.REPEAT N=1 5.DATA PRINT NO 6.NON-LINEAR W.CURVE NO 7.FILE		
28	For filing ..... Not for filing		29 31
29	To select the filing mode:	[YES] [7] [ENTER]	
30	Filing:	Refer to 4.2.2.	27
31	If an unknown sample measurement is to be made: If an unknown sample measurement is not to be made:	[NO]	25 32
32	To measure standard samples again, return to the parameter change display and enter analytical parameter Nos. 1, 2 or 6.(*) You may alter the entry for the analytical parameter selected if necessary. To change the analytical parameter No. 3, 4 or 5 for unknown sample measurement: To terminate the measurement:	[RETURN] [YES] [1] or [2] or [6] [ENTER] [YES] [3] or [4] or [5] [ENTER]	3 31 33
33	End. When the [RETURN] key is pressed, the system goes to Step 27. Then, when the [MODE] key is pressed, the basic mode menu appears on the CRT.		

*ATTENTION
If one of the analytical parameters No. 1, 2, or 6 has already been selected and a working curve established, calling back up analytical parameters No. 1, 2, or 5 will erase the previously established working curve unless such a working curve has been stored in a file.

4.7.3 Repeated Measurements

If the measuring parameter No. 4 REPEAT is set to 2 or more, repeated measurements can be made for the same sample to use their average as the data. In Fig. 4.32, the average (MEAN) of 3 measurements (N=3) of the standard sample STD1 is used as the data. In Fig. 4.33, [RETURN] key is pressed during repeated measurements, and so the last measurement (2nd measurement) is regarded as the data for STD2 in spite of N=3. The above two examples are calibrations of working curve. On the other hand, Fig. 4.34 shows the case of repeated measurements of an unknown sample. In this case, another repetition number than above, can be set.

CALIBRATION SET STD. No. 2 PRESS START KEY

STD. No.	CONC.	ABS.	No.	ABS.
1	0.0000	0.641	1	0.641
2	1.0000		2	0.639
3	2.0000		3	0.641
4	3.0000			
5	4.0000		MEAN	0.641

Fig. 4.32 The Case When Average of 3 Measurements is Used as Data.

CALIBRATION SET STD. No. 3 PRESS START KEY

STD. No.	CONC.	ABS.	No.	ABS.
1	0.0000	0.641	1	0.641
2	1.0000	0.640	2	0.640
3	2.0000		3	
4	3.0000			
5	4.0000		MEAN	

Fig. 4.33 The Case When RETURN key is Pressed During Repetition.

QUANT. SET SAMPLE, PRESS START KEY

No.	ABS.	CONC.	No.	ABS.
1	0.638	1.3773	1	0.636
			2	0.639
			3	0.638
			MEAN	0.638

Fig. 4.34 Repeated Measurement of Unknown Sample

4.8 Multi-Component Determination Mode (MULTI-COMPONENT)

This mode is used to determine the concentration of each component of a mixture sample (containing multiple components) from the measured mixture absorption curve. The features of this mode are as follows:

(1) Up to 8 components can be analyzed.

(2) Both pure standard samples and mixed standard samples (comprised of at least 2 and up to 8 components) of known concentrations can be used. With such flexibility, the interference among the components can be dramatically reduced. The number of standards that can be used when using mixed standard samples ranges from (the number of components plus 1) to 16.

(3) Both the analytical parameters and standard sample measured data can be filed in the backed-up memory. Thus, in later measurements it is possible to measure unknown samples without having to recalibrate.

(4) The measuring wavelengths can be spaced either equally or arbitrarily depending on the measuring purpose. The number of measuring wavelengths ranges from the number of components (applicable when pure component standard samples are used) to the number of standard samples minus 1 (applicable when mixed standard samples are used). Fig. 4.27 shows an example of the results of a measurement using the MULTI-COMPONENT mode.

When the MULTI-COMPONENT mode is selected, the display shown in Fig. 4.28 is indicated on the CRT. A description of the analytical parameters in this mode is given in Table 4.12.

ATTENTION

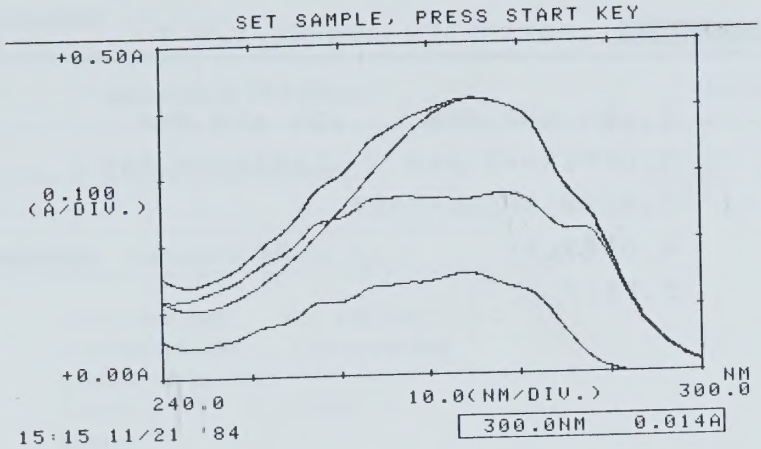
(1) When the measured standard samples provide non-usable spectral data for purposes of multi-component calculations, the CRT displays the following sign.

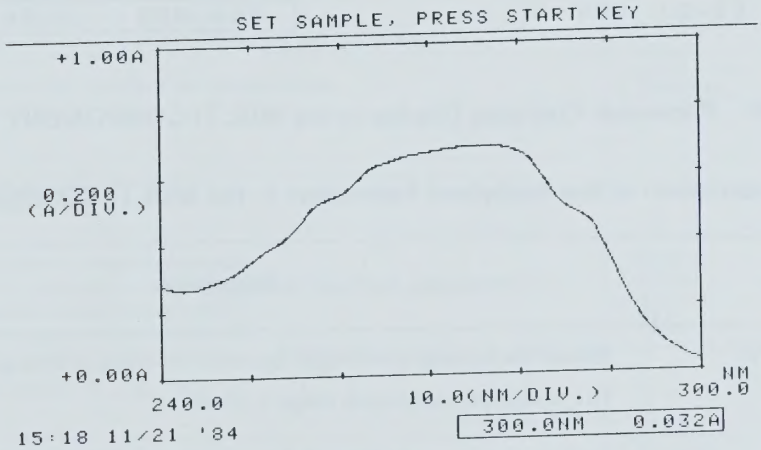
NO SOLUTION

At that time, press the RETURN key. The system then returns to the parameter changing display. Try to measure the standard samples again. There are 2 situations that can cause the NO SOLUTION status. Either (1) the absorbance data at a selected wavelength(s) is almost zero and/or (2) two or more standard samples spectra are practically identical.

(2) When a standard sample shows ABS 0 or almost ABS 0 over the measuring wavelength range, accurate multi-component calculation can not be made. At this time, NO SOLUTION may be displayed on the CRT. On rare occasions, the NO SOLUTION display won't appear, yet the correct results cannot be obtained.

(3) When using mixed standard samples having more than 4 components each, the probability of acquiring a NO SOLUTION status becomes high.





** MULTI-COMP. ANALISYS **

No.	COMP. No.	CONC.
1	1	19.691
	2	20.209
	3	118.24

Fig. 4.27 Example of the Results of a Measurement in the MULTI-COMPONENT Mode

```
MULTI.COMP.   PARAMETER CHANGE Y/N ?

        1.λS= 800.0NM     λE= 400.0NM
        2.UPPER=+2.00A     LOWER=+0.00A
        3.SCAN SPEED=FAST
        4.OVERLAY            NO
        5.FILE

20:02 11/01 '84                  800.0NM    0.000A
```

Fig. 4.28 Parameter Changing Display in the MULTI-COMPONENT Mode

Table 4.12 Description of the Analytical Parameters in the MULTI-COMPONENT Mode

Item [Valid entries]	Description
1. λ_S, λ_E [200 ~ 1100] ($\lambda_S - \lambda_E \geqq 10$)	Means the starting wavelength λ_S and the ending wavelength λ_E The minimum wavelength range is 10nm.
2. UPPER, LOWER [-2.5 ~ 2.5] (UPPER - LOWER $\geqq$ 0.01)	Used to determine the measuring range. The minimum full scale range is 0.01 Abs.
3. SCAN SPEED [FAST, MED, SLOW]	Used to set the wavelength scanning speed in three steps; FAST, MEDIUM, and SLOW.
4. OVERLAY [YES, NO]	When this parameter is set to YES, overlapped spectra can be recorded.
5. FILE	To be selected for filing. Select this parameter No. ONLY when the standard sample measurement is finished.

Operating procedure:

Step	Operation & CRT display	Key operation	Next step
1	Select mode No. 6 (MULTI-COMPONENT).	MODE 6 ENTER	
2	MULTI.COMP. PARAMETER CHANGE Y/N ? 1.λS= 800.0NM λE= 400.0NM 2.UPPER=+2.00A LOWER=+0.00A 3.SCAN SPEED=FAST 4.OVERLAY NO 5.FILE		
3	Set the analytical parameters.	Refer to Section 4.2.1.	
4	COMP. NUMBER ? (2–8)		
5	Manually enter the number of components.	Number ENTER [2~8]	
6	MIX. STD. Y/N ?		
7	If mixed standard samples are used: (one or more standards containing more than one component) If pure standard samples are used: (only one component per standard)	YES NO	8 10
8	STD. NUMBER ? (X–16) " "		
9	Manually enter the number of standard samples.	Number ENTER [No. of comp. + 1 ~ 16]	
10	SAMPLING dλ ? " " NM		
11	If arbitrary sampling wavelengths are to be chosen: If regular sampling wavelengths are to be chosen: (In this case wavelengths are set from λs with selected regular interval. The interval must be from 1 to 99 (nm). Furthermore, the interval is restricted with the following condition.) 1. For mixed standard samples $\frac{\lambda_S - \lambda_E}{N-1} < \triangle\lambda \leq \frac{\lambda_S - \lambda_E}{M-1}$ 2. For pure standard samples $\frac{\lambda_S - \lambda_E}{N(M)} < \triangle\lambda \leq \frac{\lambda_S - \lambda_E}{M-1}$ N: number of standard samples M: number of components * Next step is 12 for MIX. STD. and 14 for PURE STD.	0 ENTER Number ENTER [Enter the wavelength interval]	12 or 14* 16
12	SAMPL. POINT NUMBER ? (X–X) " "		
13	Manually enter the number of sampling wavelengths.	Number ENTER [Enter No. between No. of components and No. of standards –1]	

Step	Operation & CRT display	Key operation	Next step
14	SAMPLING λ(1) = ××××.×		
15	Enter the sampling wavelengths.	Value ENTER ⋮ ⋮ [λS ~ λE] (as many times as the No. of sampling wavelengths)	
16	CALIBRATION CHANGE PARAM. Y/N ? SAMPLING λ COMP. 4 600.0 MIX. STD. 8 593.0 586.0 579.0 572.0 565.0 558.0		
17	If any of the foregoing entries are to be changed: If none of the foregoing entries are to be changed:	YES NO	4 18
18	STD. No. 1 COMP. No. 1 CONC. = 1.0000 STD. 1 STD. 2 STD. 3 STD. 4 COMP. 1 COMP. 2 COMP. 3 COMP. 4 STD. 5 STD. 6 STD. 7 STD. 8 COMP. 1 COMP. 2 COMP. 3 COMP. 4		
19	Enter the concentration of each component.	Value ENTER ⋮ ⋮ [0.0001 ~ 9999.9] Enter as many times as No. of components times No. of standards if they are mixture. Enter as many times as No. of components if standards are pure.	

Step	Operation & CRT display	Key operation	Next stpe
20	CHANGE CONC. Y/N ? STD. 1 STD. 2 STD. 3 STD. 4 COMP. 1 0.0000 1.0000 2.0000 3.0000 COMP. 2 1.0000 2.0000 3.0000 2.0000 COMP. 3 2.0000 3.0000 4.0000 1.0000 COMP. 4 3.0000 4.0000 5.0000 0.0000 STD. 5 STD. 6 STD. 7 STD. 8 COMP. 1 2.0000 1.0000 1.0000 2.0000 COMP. 2 1.0000 0.0000 1.0000 3.0000 COMP. 3 0.0000 1.0000 1.0000 2.0000 COMP. 4 1.0000 2.0000 1.0000 1.0000		
21	If any of the standard concentration data is to be changed: If none of the standard concentration data is to be changed:	YES NO	22 26
22	STD. NO. = 01		
23	Enter the standard sample No. for data change.	Number ENTER	
24	STD NO. ×× COMP NO. ×× CONC. = ××××		
25	Enter the concentration of each component.	Value ENTER ⋮ ⋮ (As many times as No. of components. Only once if standard is pure sample.)	20
26	If this step is for the first time, with 9 or more standard samples: (*) If this step is for the second time or if No. of standard samples is 8 or less:	…… ……	18 27
27	SET STD. NO. 01 PRESS START KEY		
28	Insert a standard sample, and start a measurement.	START / STOP ⋮ (As many times as No. of standards.)	
29	■ PROCESSING		
30	Wait until the processing is completed.		
31	SET SAMPLE, PRESS START KEY		

(*) The reason for this step is that the CRT can only display a maximum of 8 standards at a time.

Step	Operation & CRT display	Key operation	Next step
32	To measure an unknown sample, insert it and then start a measurement: To return to the parameter changing display: To terminate the measurement:	[START/STOP] [RETURN]	33 34 40
33	The spectrum is displayed on the CRT and at the same time the result is printed out on the printer.		32
34	PARAMETER CHANGE Y/N ?		
35	For filing Not for filing		36 38
36	To select the filing mode:	[YES] [5] [ENTER]	
37	Filing	Refer to Section 4.2.2.	34
38	To measure the next unknown sample: Not to measure the next unknown sample:	[NO]	31 39
39	To measure new standard samples, select the analytical parameter No. 1 [λ_S = λ_E =](*) To change parameter No. 2, 3 or 4 for unknown samples: To terminate the measurement:	[YES] [1] [ENTER] [YES] [2] or [3] or [4] [ENTER]	3 38 40
40	End. When the [RETURN] key is pressed, the system is returned to Step 34. Then, when the [MODE] key is pressed, the basic mode menu appears on the CRT.		

(*) CAUTION

When selecting analytical parameter No. 1, the data of the previously measured standard samples are all cleared.

4.9 MEMORY OUT Mode

This mode is used to recall data such as spectra or time-course curves saved in the SPECTRUM mode or the TIME SCAN mode. There are 2 independent channels available for data storage (CH1 and CH2). In channel 0, the data from the last run spectra or time-course curve is automatically saved. If data from two or three channels are desired to be recalled on the CRT in an overlay fashion, their abscissas scales and SURVEY SCAN parameter MUST coincide with one another (all must have the same starting and ending wavelengths).

Single-wavelength data in the photometric mode, are stored in CH0 successively during the measurement. If 10 or more data are stored, a file is made in CH0 with the sample No. in the abscissa, as shown in Fig. 4.29. This is displayed in CHANNEL DISPLAY as a pattern of data distribution, as shown in Fig. 4.30. In addition, this data can be processed only in SAVE, EXP (only for ordinate scale) and PLOT.

Notes:

- The saved data will be permanently lost when the power switch is turned off because such data is not battery protected.
- The saved data will be permanently lost when the modes other than Nos. 1, 2, 3, 7 and 8 are used (mode 4, 5, 6 and 9).

When the MEMORY OUT Mode is selected, the display shown in Fig. 4.29 is indicated on the CRT. A description of each function in this mode is given in Table 4.13. On the lower half of the screen, the relationship with the wavelength-axis, time-axis or sample No. per channel, is displayed.

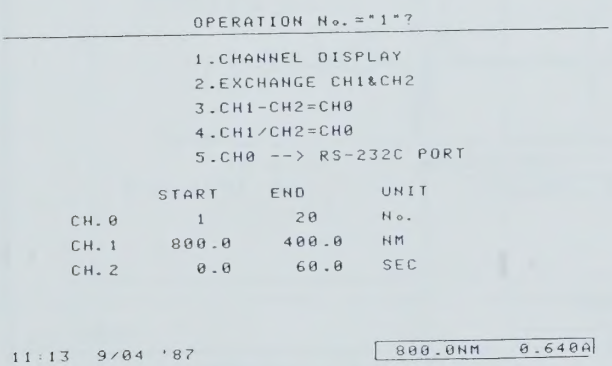


Fig. 4.29 Function Choise Display in the MEMORY OUT Mode

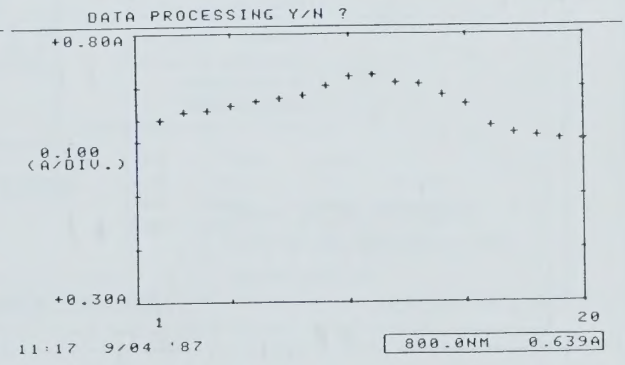


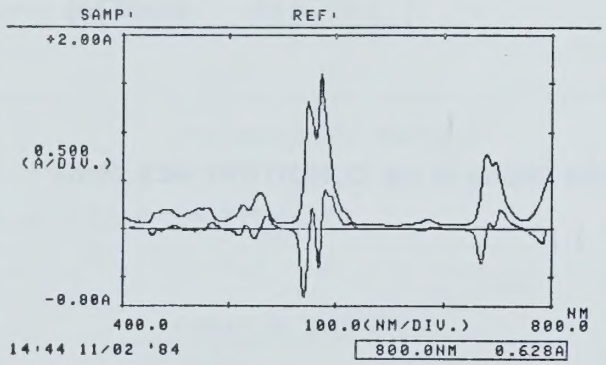
Fig. 4.30 Distribution of Single-Wavelength Data in Photometric Mode

Table 4.13 Description of Each Function in the MEMORY OUT Mode

Item	Description
1. CHANNEL DISPLAY	Used to recall data from CH.0, CH.1 and/or CH.2. If two or more channels are to be recalled on the same screen, their abscissa scales and SURVEY SCAN parameter must coincide with each other, and in this case, the ordinate scale of the lowest channel number is the one used if different ordinate scales exist between the channels. If dara from just one channel is recalled, it can be data-processed.
2. EXCHANGE CH. 1 & CH. 2	Used to interchange CH. 1 data and CH. 2 data. In this case, thier abscissa scales must coincide with one another.
3. CH. 1 - CH. 2 = CH. 0	Used to recall the results of CH. 1 data minus CH. 2 data and at the same time save the resultant into CH. 0. Their abscissa scales must coincide with one another.
4. CH. 1/CH. 2 = CH. 0	Used to recall the results of CH. 1 data divided by CH. 2 data and at the same time save the resultant into CH. 0. Their abscissa scales must coincide with one another.
5. CH. 0 → RS-232C PORT	If the RS-232C (interface) is connected, the data in channel CH. 0, are always outputted into the RS-232C output port.

Operating procedure:

Step	Operation & CRT display	Key operation	Next step
1	Select mode No. 7 MEMORY OUT.	MODE 7 ENTER	
2	OPERATION No.="1"? 1.CHANNEL DISPLAY 2.EXCHANGE CH1&CH2 3.CH1-CH2=CH0 4.CH1/CH2=CH0 5.CH0 --> RS-232C PORT START END UNIT CH.0 1 20 No. CH.1 800.0 400.0 NM CH.2 0.0 60.0 SEC 11:13 9/04 '87 800.0NM 0.640A		
3	To recall data saved in the channels: To interchange CH. 1 data and CH. 2 data: To recall CH. 1 data minus CH. 2 data: To recall CH. 1 data divided by CH. 2 data: To output CH. 0 into the RS-232C:	1 ENTER 2 ENTER 3 ENTER 4 ENTER 5 ENTER	4 10 11 12 12

Step	Operation & CRT display	Key operation	Next step
4	CH. X DISPLAY Y/N ?		
5	Select the channel Nos. whose data is to be recalled.	YES or NO (3 times)	
6	If NO is pressed three times or if the data from different channels to be recalled have different abscissa scales		2
	If only one channel is chosen		7
	If two or more channels are chosen		12
7	DATA PROCESSING Y/N ?		
8	To process the recalled channel data:	YES	9
	Not to process the recalled channel data:	NO	12
9	Refer to Data Processings in the SPECTRUM mode or the TIME SCAN mode		7
10	Data interchange is immediately executed		2
11	If CH. 0 has a data, and also the RS-232C interface is connected, the data will be output. During outputting, "PROCESSING" is displayed.		2
12		Note: In the MEMORY OUT mode, the cursor can not be shifted.	
13	End. When the RETURN key is pressed, the system returns to Step 2. Then, when the MODE key is pressed, the basic mode menu appears on the CRT.		

4.10 CONDITION SET Mode

This mode is not used for analysis but for setting various conditions which are operational independent of the basic measuring mode being used.

When this mode is selected the display in Fig. 4.31 appears on the CRT. A description of each function in this mode is given in Table 4.14.

```
                    PARAMETER No.="1"?
------------------------------------------------------------
                    1.BASELINE
                    2.CLOCK SET
                    3.CLOCK DISPLAY
                    4.LAMP CHANGE λ
                    5.LAMP SELECT
                    6.FILE DELETE

19:54 11/01 '84                    800.0NM    0.627A
```

Fig 4.31 Conditional Choise Display in the CONDITION SET Mode

Table 4.14 Description of Each Condition in the CONDITION SET Mode

Item	Description
1. BASELINE	Used to correct the baseline over the range of starting wavelength λ_S to ending wavelength λ_E defined in the SPECTRUM mode. (When $\lambda_E \leqq 364$nm, from λs to 200nm)
2. CLOCK SET	Used to set the built-in clock which operates on a continuous 24hr. basis. The clock is battery protected.
3. CLOCK DISPLAY	Used to turn the clock display on or off. The CLOCK DISPLAY changes from ON to OFF or from OFF to ON when this item is chosen.
4. LAMP CHANGE λ	Used to set the lamp changeover wavelength within the range of 295 nm to 364 nm. The initial setting is 350.5 nm. For example, when it is set to 300 nm, the halogen lamp works at 300 nm or more and the deuterium lamp works at 299.9 nm or less.
5. LAMP SELECT	Used to turn off the lamp which is not used at the current wavelength. To turn on the lamp which was turned off, set a wavelength within this lamp's operating range.
6. FILE DELETE	Used to delete unnecessary files. For example, before saving a file for multi-component analysis, it is necessary to delete all files for non-linear working curves using this function.

Operating procedure:

Step	Operation & CRT display	Key operation	Next step
1	Select mode No. 8 CONDITION SET.	[MODE] [8] [ENTER]	
2	PARAMETER No.="1"? 1.BASELINE 2.CLOCK SET 3.CLOCK DISPLAY 4.LAMP CHANGE λ 5.LAMP SELECT 6.FILE DELETE		

Step	Operation & CRT display	Key operation	Next step
3	To make a baseline correction: To set the clock: To change the clock display from ON to OFF or from OFF to ON: To set the lamp changeover wavelength: To turn off the lamp which is not used: To delete a file:	[1] [ENTER] [2] 〃 [3] 〃 [4] 〃 [5] 〃 [6] 〃	4 5 7 8 10 11
4	The baseline correction starts. ..... (To stop the process in transit, press the START/STOP key.)		2
5	×× : ×× ××/×× '××		
6	Enter the time and date in the order of hour, min., month, day and year.	[Number] [ENTER] [0～23] [Number] 〃 [0～59] [Number] 〃 [1～12] [Number] 〃 [1～31] [Number] 〃 [0～99]	2
7	The clock display changes from ON to OFF or from OFF to ON.		2
8	LAMP CHANGE λ =××××.×		
9	Enter the lamp changeover wavelength:	[Value] [ENTER] [295.0～364.0]	2
10	The lamp not used is turned off.		2
11	DELETE ANY FILE Y/N ?		
12	To delete a file: Not to delete any files:	[YES] [NO]	13 2
13	DELETE FILE NO. = " "		
14	Enter the file No. to be deleted:	[Number] [ENTER] [1～20]	11

4.11 ATTACHMENT Mode

This mode is chosen when an optional attachment is connected. For the details, refer to the instruction manual for the optional attachment used.

Note. The UV-160A comes standard with the following accessory related software:

(1) Software to conduct sipper operation (used with the Sipper 160 accessory P/N 204-08270-01~-03)

(2) Software to conduct external analog spectrum recording (used with the Analog Output Interface accessory P/N 204-04757)

(3) Software to conduct external analog time scan recording (used with the Analog Output Interface accessory P/N 204-04757)

(4) Software to conduct the data print function for the cell positioner (used with the Cell Positioner CPS-240A accessory P/N 204-05837-01)

(5) Software to conduct the cell positioner kinetic measurements (used with the Cell Positioner CPS-240A accessory P/N 204-05837-01),

Caution

(1) AC100V power inlet is provided on the rear side of the SPECTOROPHOTOMETER. It is used for supplying the AC power to the following optional accessories.

① Gel scanner GSC-3A

② Auto sample changer ASC-3

③ Recorder U-135

④ Plotter for the UV-160 (P/N 206-15788)

When connecting the other external devices, power line noise from these devices may cause the malfunctioning of UV-160. In that case, the noise filter (P/N 200-80510) is recommended.

(2) Do not connect the devices which exceed the rated power eapacity of AC100V 0.4A.

Chapter 5 Maintenance

5. Maintenance

5.1 Routine and Regular Checks

(1) Checking the Sample Compartment Floor (daily check)

When large amounts of liquid samples are used, confirm before and after each measurement that there is no spilt liquid deposited on the floor of the sample compartment. If such spilt liquid is allowed to remain, its vapor may come into the optical paths thus causing a measuring error.

(2) Checking for Contamination of Lenses on the Sample Compartment Left Side (weekly check)

Check once a week that the lenses at the optical path exit of the sample compartment are not contaminated with finger-prints or other debris. If they are significantly contaminated, a measuring error may occur (e.g. severe non-linearity etc.)

If one of them is contaminated, first pull out the sample compartment unit, and then remove the lens pressing spring. Take out the contaminated lens and wipe it with a clean cloth soaked with alcohol.

The silica window plates at the optical path entrance of the sample compartment are hardly liable to be contaminated because their positions are greatly recessed from the compartment inner walls. If they are contaminated, contact our nearest service office.

5.1 Initialization with Error Messages

When the power switch is turned on, the spectrophotometer makes various checks and sets many initialized parameter values according to Table 5.1. If no abnormality is detected, the instrument goes to Step (12) after nearly 1.5 min. However, if an abnormality is detected at a step, the instrument stops there while indicating the appropriate error message shown on the right side of Table 5.1. In such a case, identify the problem source, if possible, and correct it. If the problem source is uncorrectable, contact Shimadzu's service office and indicate the error messages.

Note: After the initialization, if the monochromator wavelength goes outside the measuring wavelength range for whatever reason, the instrument stops with the error message "**DRIVE ERROR".

Table 5.1 Initialization Process

Step	Automatic operation after being energized	CRT display	Error message in case of abnormality
1	Detection of wavelength origin	*** UV-160 SPECTROPHOTOMETER *** INITIALIZATION	** LIMIT ERROR
2	Shift to 310nm (temporary)		
3	Lighting of D lamp		
4	Optical alignment of D_2 lamp Energy check of D_2 lamp		** D2 ENERGY ERROR X.XXXA where X.XXXA means the energy level. (Note *1)
5	Detection of filter origin		** FILTER ERROR (Note *1)
6	Detection of D_2 line spectrum of 486.0nm		** λ ERROR XXXX
7	Detection of D_2 line spectrum of 656.1nm		where XXXX is the wavelength interval of between these two line spectra.
8	Shift to 656.1nm		
9	Filter insertion		
10	Lighting of WI lamp		
11	Optical alignment of WI lamp Energy check of WI lamp		** W ENERGY ERROR X.XXXA where X.XXXA means the energy level. (Note *1)
12	Baseline correction (1100 ~ 200nm)	BASELINE CORRECTION	The baseline correction can be stopped by pressing START/STOP key.
13	Display of mode selection menu	Mode selection menu	

Note *1: The system status proceeds to the next step when any key is pressed.

5.3 Trouble Shooting

If the spectrophotometer malfunctions, it probably is due to the deterioration of consumable parts, operator mis-operation or incomplete maintenance. Make checks according to the following table. If a major difficulty occurs, contact our company.

(1) The system does not operate at all or no CRT display appears.

Check point	Remedy
1. Is the power cable securely connected?	Connect it securely.
2. Is the power fuse blown?	Replace the fuse: 5A one for 110 ~ 117V 3A one for 220 ~ 240V
3. Is the brightness control properly set?	Readjust it.

(2) Error messages appear during initialization or measurement.

Error message	Remedy
1. ** LIMIT ERROR 2. ** DRIVE ERROR	Inform our service personnel of the error message.
3. ** D_2 ENERGY ERROR 4. ** W ENERGY ERROR	① Open the light source housing and confirm that the lamp is lit. If not, turn the power switch off and then on. If the lamp still cannot be lit, replace the lamp. ② Confirm that there is no opaque object in the sample compartment. If any, remove it and turn on the power switch again. ③ Confirm that the lamp radiation passes securely through the entrance slit of the monochromator. For this, remove the light source cover and make a visual check through the monitoring hole. If the lamp radiation is misaligned, contact our service personnel.
5. ** FILTER ERROR ** λ ERROR	① Confirm that the sample compartment lid is securely closed. If not, close it and turn on the power switch again. ② Confirm that there are no objects in the optical paths of the sample compartment. If any, remove them and turn on the power switch again.

(3) Numerical entries cannot be made on the keyboard.

Cause	Remedy
1. Invalid numerical value is entered. For example: λS = 1150nm	Enter a valid numerical value.
2. Computer IC's or keyboard is defective.	Contact our service personnel.

(4) Baseline is not flat.

Cause	Remedy
1. The baseline correction was made with too absorptive a sample.	Recorrect the baseline with an air blank (or without any cell).
2. The wavelength range where the baseline correction was made did not totally include the measuring wavelength range.	Recorrect the baseline for a broader wavelength range equal to or greater than the measuring wavelength range.

(5) Measured values are abnormal.

Cause	Remedy
1. [AUTO ZERO] key was pressed by mistake during a measurement.	Again press [AUTO ZERO] key with a blank solution or air in the sample position.
2. The sample preparation is faulty.	Properly prepare the sample.
3. The kind of cell used isn't proper.	e.g. Don't use a glass cell for the ultraviolet region.

5.4 Light Source Replacement

Precautions:

(1) The light source and light source housing are considerably heated during operation. Therefore, be sure to turn off the power switch so as to cool down the light source sufficiently before replacing the light source.

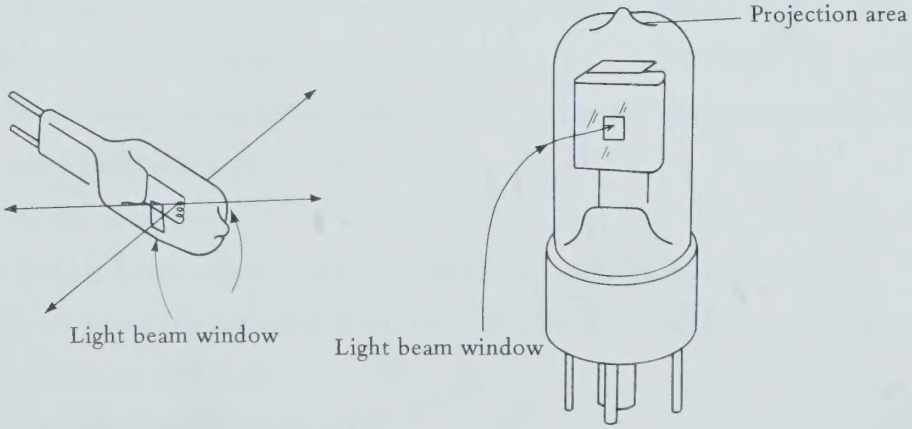
(2) Hold the light source with gloves on your hands so as not to leave finger-prints. If handled with naked hands, the heated light source is liable to be contaminated with finger-prints thus deteriorating its light transmitting ability.

(3) **Be careful not to strike the projection area on the top side of the deuterium lamp with the light source cover during handling of the light source cover. If it is damaged,** a leakage in the envelope vacuum may occur. It furthermore should be noted that although the D_2 lamp may visually appear fine after receiving an impact in the projection area, a vacuum leak still may have been realized.

5.4.1 Light Source Specifications

Table 5.2 Light Source Specifications

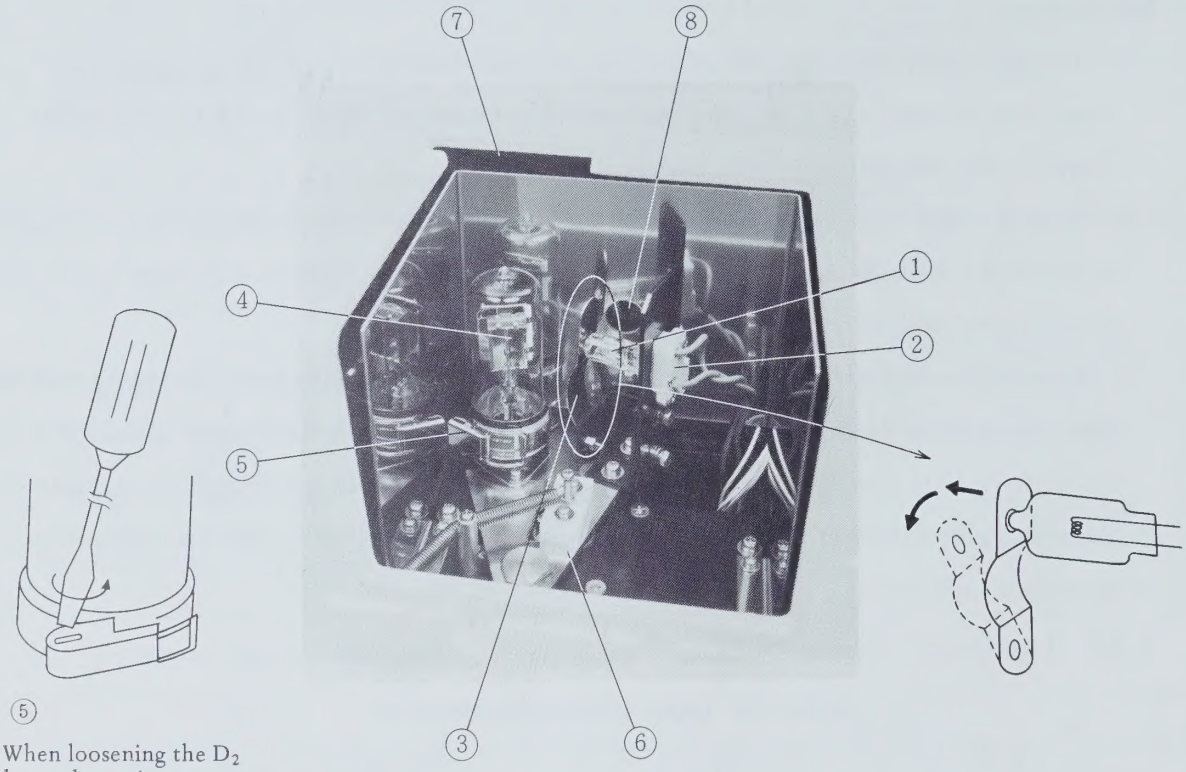
	WI lamp	D_2 lamp
Part No.	062-65004-06	062-65055-01
Model	RJ5012	DS-350U
Mean life-time	2000 hrs.	500 hrs.
Specifications	12V, 50W	Discharge voltage: 75 ~ 95V Discharge current: 300mA Firing voltage: 230 ~ 350V
Type	(a) in Fig. 5.1	(b) in Fig. 5.1



(a) WI lamp **(b) D_2 lamp**

Fig. 5.1 Outside View of the Light Sources

5.4.2 Light Source Replacement Procedure



When loosening the D_2 lamp clamp, insert a screwdriver into the hole and slowly rotate the screwdriver in the arrow-marked direction.

①	WI lamp	⑤	D_2 lamp clamp
②	WI lamp socket	⑥	Light source change-over mechanism
③	Pressing spring for WI lamp	⑦	Alignment checking window
④	D_2 lamp	⑧	Light beam emitting window

Fig. 5.2 Inside View of the Light Source Housing

Replacement of the WI lamp

(1) Remove the light source housing cover by placing 2 fingers in the 2 depressions located on the right side of the instrument and pull upwards.

(2) Place a non-flammable barrier between both lamps to avoid inadvertently contaminating the surface of the D_2 lamp with fingerprints. If placing such a barrier too severly inhibits your ability to remove the WI lamp pressing spring from the tip of the lamp, then you may remove the D_2 lamp. If you elect to remove the D_2 lamp, wear gloves and use extreme caution to prevent damaging the D_2 lamp. To remove the D_2 lamp, first loosen its clamp by inserting the accessory regular screwdriver into the hole in the clamp and gently rotate it counterclockwise. Then, slowly pull the D_2 lamp out of its socket as shown in the left-side view of Fig. 5.2.

(3) Pull the WI lamp out of its socket.

(4) Insert a new WI lamp into the socket while holding the top and bottom sides of the lamp with gloved hands thus preventing finger-prints from being left on the light beam emitting window. At this time, securely and deeply insert the lamp until its pins are stopped by the socket holes. There is no polarity in the lamp connector pins (it doesn't make any difference which way you plug in the WI lamp).

(5) Fit the hole of the pressing spring onto the tip of the WI lamp in order to hold the lamp securely.

(6) Restore and deeply insert the removed D_2 lamp into its socket (if you elected to remove it), and then fix it by its clamp usig the accessory regular screw-driver as before.

(7) Put on the light source housing cover.

Replacement of D_2 lamp

(1) Remove the light source housing cover by placing 2 fingers in the 2 depressions located on the right side of the instrument and pull upwards.

(2) Insert the accessory regular screw-driver into the hole in the lamp clamp and gently rotate it counterclockwise to loosen it.

(3) Pull up the D_2 lamp slowly.

(4) Insert a new D_2 lamp with gloved hands deeply and securely into the socket.

(5) Insert the accessory regular screw-driver into the hole in the lamp clamp and gently rotate it clockwise to tighten it.

(6) Restore the light source housing cover.

After the light source replacement, pull the light source housing cover back approximately 1/2 inch to expose the alignment checking window and turn on the power switch and wait for the initialization to be complate. Through the light source alignment checking window (⑦ in Fig. 5.2) confirm that the lamp radiation passes properly through the entrance slit of the monochromator. The lateral lamp alignment is automatically made, but a vertical misalignment may occur if the lamp is improperly replaced. Then fully restore the light source cover to its proper position.

5.5 Precautions on Handling the Thermo-Sensitive Chart Paper

Pay strict attention to the following points regarding the storage and handling of the thermo-sensitive chart paper before and after measurements.

(1) Avoid a place with high temperature or high humidity: At a temperature of more than 50°C, don't locate the chart paper near a high-temperature unit nor in a moist place. Observing such precautions will prevent deterioration of the paper's coloring property and surface condition.

(2) Don't expose the chart paper to strong light: Don't expose the chart directly to direct sunshine, nor leave the chart under a fluorescent lamp for a long time. However, electrical copying is permissible.

(3) Don't bring the chart paper into contact with organic solvents or copying solutions. The chart paper is discolored by making contact with organic adhesives. Additionally, it may be discolored by making contact with a fresh wet photocopy. (It is not discolored with petroleum solvents such as gasoline and benzine.)

(4) Avoid activating plasticizers: Avoid polyvinyl chloride resins and vinyl bags. Detergents and synthetic resins which contain highly concentrated plasticizers such as soft polyvinyl chloride and also vinyl bags may deteriorate the coloring property of the chart paper when they make direct contact with it.

(5) Avoid rubbing the paper with a hard object. Also, avoid manually writing on the chart paper WITH unused chart paper below it. The unused chart paper may get damaged.

5.6 List of Consumable and Renewal Parts

	Description	Model	Part No.
1	Thermo-sensitive chart, FTP-040		200-91532-02
2	Halogen lamp	RJ5012	062-65004-06
3	Deuterium lamp	DS-350U	062-65055-01
4	Slide plate for sample compartment		204-07348
5	Cell holder assembly		202-30215
6	Fuse 5A, for 100 ~ 120V		072-01027
	Fuse 3A, for 200 ~ 240V		072-01005
7	Silica cell, 10mm, rectangular (1 pc.)		200-34442
8	Didymium filter		202-30242
9	Power cable with plug, for 100V		200-81008-01
	Power cable with plug, for 200V		200-81008-02
10	Grounding adapter		071-60803
11	Chart axle		204-06895
12	CPU PC board assembly		204-07450
13	Power PC board assembly		204-04621
14	Preamplifier assembly		204-06928
15	Printer	FTP040-MCS004	204-08992
16	CRT	TR0A1	200-91301
17	Keyboard		200-76043
18	Standard accessories kit		
	(contains No. 2 ~ 6 in the Table 1.1)		
	for 100 ~ 120V		204-04672
	for 200 ~ 240V		204-04672-01

Chapter 6 List of Options

6. List of Options

6.1 Optional Cells (Refer to Fig. 6.1)

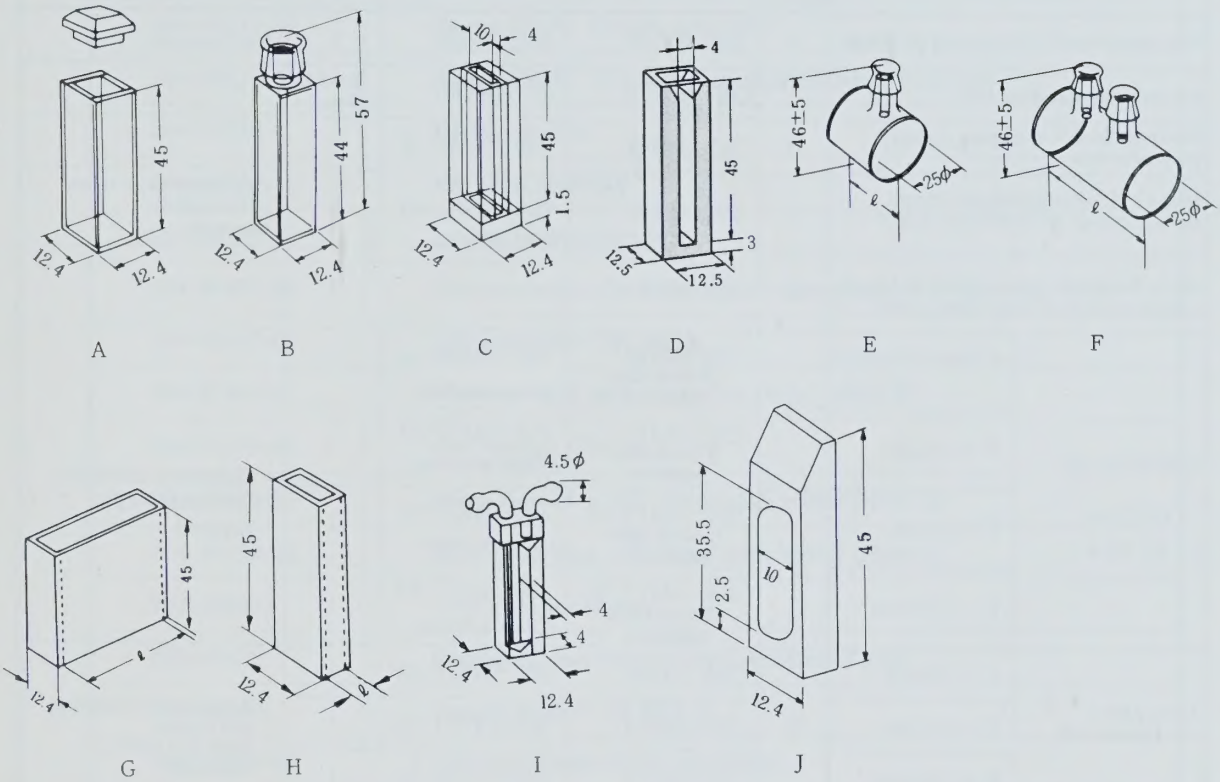


Fig. 6.1 Types of Optional Cells

Table 6.1 List of Optional Cells

Description		Type in Fig. 6.1	Fused silica (S cell)	Glass (G cell)	Qt.	Dedicated holder
Rectangular cell, optical path of 10mm		A	200–34442	200–34565	1	Not required
Rectangular matching cell		A	201–98716	201–98746	Set of 2 pcs.	〃
Rectangular cell with plug, optical path of 10mm		B	200–34444	200–34444–01	1	〃
Micro cell, optical path of 10mm, sample volume of more than 1.0mℓ		C	200–66501	200–66501–01	1	Cell holder with mask (204-06896) required
Micro black cell, optical path of 10mm, sample volume of more than 1.0mℓ		D	200–66551		1	〃
Cylindrical cell OD 25 ϕ ID 22 ϕ	ℓ (optical length)= 10 mm	E	200–34448 (Fused-silica window)	200–34448–01 (Glass window)	1	Cylindrical cell holder (204-06216-02), required
	ℓ = 20 mm		200–34472 (Fused-silica window)	200–34472–01 (Glass window)	1	
	ℓ = 50 mm	F	200–34473–01 (Fused-silica window)	200–34473–03 (Glass window)	1	
	ℓ = 100 mm		200–34473–02 (Fused-silica window)	200–34473–04 (Glass window)	1	
Long path rectangular cell	ℓ = 20 mm	G	200–34446	200–34446–01	1	Long path rectangular cell holder (204-23118-01), required
	ℓ = 50 mm		200–34944	200–34944–01	1	
	ℓ = 100 mm		200–34676	200–34676–01	1	
Short path cell	ℓ = 1 mm	H	200–34660–01	200–34662–01	1	Spacer for short path cell required
	ℓ = 2 mm		200–34655	200–34662–11	1	
	ℓ = 5 mm		200–34449	200–34449–01	1	
Spacer for short path cell	for 1mm	J	204–21473–03		1	Not required
	for 2mm		204–21473–01			
	for 5mm		204–21473–02			

Description	Optical length	Type	Fused silica (S cell)	Capacity	Path width	Dedicated holder	Remarks
Flow-thru cell	ℓ=10 mm	I	200–34670	1.5 mℓ	4 × 36	Not required; front panel with holes, required	For general use; without tubes

6.2 Optional Attachments

Parts No.	Description
204-08270-01	Sipper 160 L (Single pass cell)
204-08270-02	Sipper 160 T (Triple pass cell)
204-08270-03	Sipper 160 C (Constant-temperature single pass cell)
204-04755	GP-IB interface
204-04753	RS-232C interface
204-04757	Analog output interface
204-05557-01	Thermoelectrically temperature controlled cell holder TCC-240A
204-05837-01	Cell positioner CPS-240A
204-51943-01	Flow-thru cell with holder for HPLC (Note 2)
204-51774-01	Gell scanner GSC-3A
204-28959-03	Micro flow-thru cell 5mm with holder (Note 2)
204-28959-02	Micro flow-thru cell 10mm with holder (Note 2)
202-30856	Opal glass attachment
200-65022	Constant-temperature water circulator TB-85
204-29230	Sample waster unit SWA-2
202-30858-04	Constant-temperature cell holder
204-27206-02	Constant-temperature 4-pcs. cell holder (Note 1)
204-23118-01	Long-path rectangular cell holder, optical path of 10~100mm
204-27208	Universal rectangular cell holder, four cell type (optical path of 10~100mm) (Note 1)
202-06216-02	Cylindrical cell holder, optical path of 10~100mm
204-06896	Cell holder with mask (for micro cell)
204-00850-01	4-cell sample compartment unit, with 4-pcs. cell holder
204-00852-01	B-type sample compartment unit
204-27588-03	Front panel with holes, for sample compartment
204-58909	Film holder
200-92504	Auto sample changer ASC-3 (Spiral type)
204-09100	Auto sample changer ASC-5 (Type X-Y)
200-91513	Strip chart recorder U-135
206-15788	Plotter with interface

Note 1: 4-cell sample compartment unit, P/N 204-00850-01 is required.

Note 2: The B-type sample compartment unit, P/N 204-00852-01 or 4-cell sample compartment unit, P/N 204-00850-01 is required.

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3400-05800-300TD-E (895)

ANALOGUE OUTPUT INTERFACE

(P/N 204-04757)

FOR

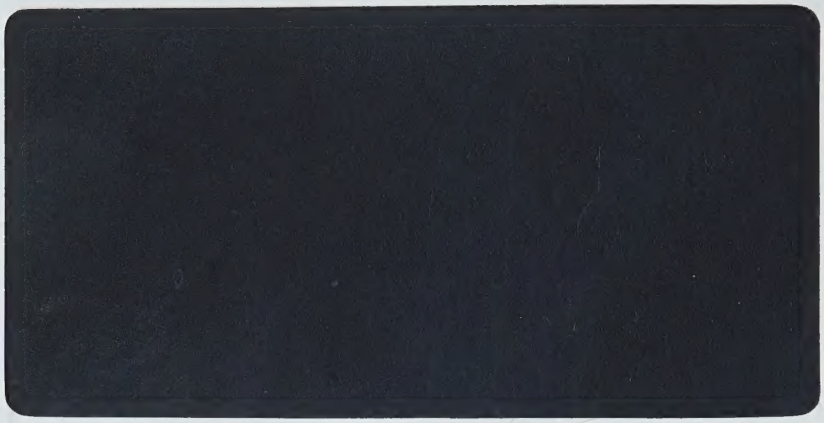
SHIMADZU UV-VIS

RECORDING SPECTROPHOTOMETER

MODEL UV-160

INSTRUCTION MANUAL

SHIMADZU



ANALOGUE OUTPUT INTERFACE
(P/N 204-04757)
FOR
SHIMADZU UV-VIS
RECORDING SPECTROPHOTOMETER
MODEL UV-160
INSTRUCTION MANUAL

SHIMADZU CORPORATION
SPECTROPHOTOMETRIC INSTRUMENTS PLANT
ANALYTICAL INSTRUMENTS DIVISION
KYOTO, JAPAN

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1. General

This interface is for sending out an analog output signal from SHIMADZU UV-VIS. Spectrophotometer Model UV-160. This combination allows to record the time course of absorbance change and absorption spectrum on an external strip chart recorder.

2. Installation

2.1 Parts Checking

When uncrated, make sure that parts listed in Table 2.1 are contained.

Table 2.1 Parts List of Analogue Output Interface

No.	Description	Quantity	Part No.
1	Analogue Output Interface	1	204-04757
2	Connection cable	1	200-79043-01
3	External recorder chart drive contact output connector	1	071-60671
4	Toothed washer	2	023-81030
5	Instruction Manual	1	CME101-028

Note: Parts ② and ④ are contained in ① as its components.

2.2 Installation on Main Unit

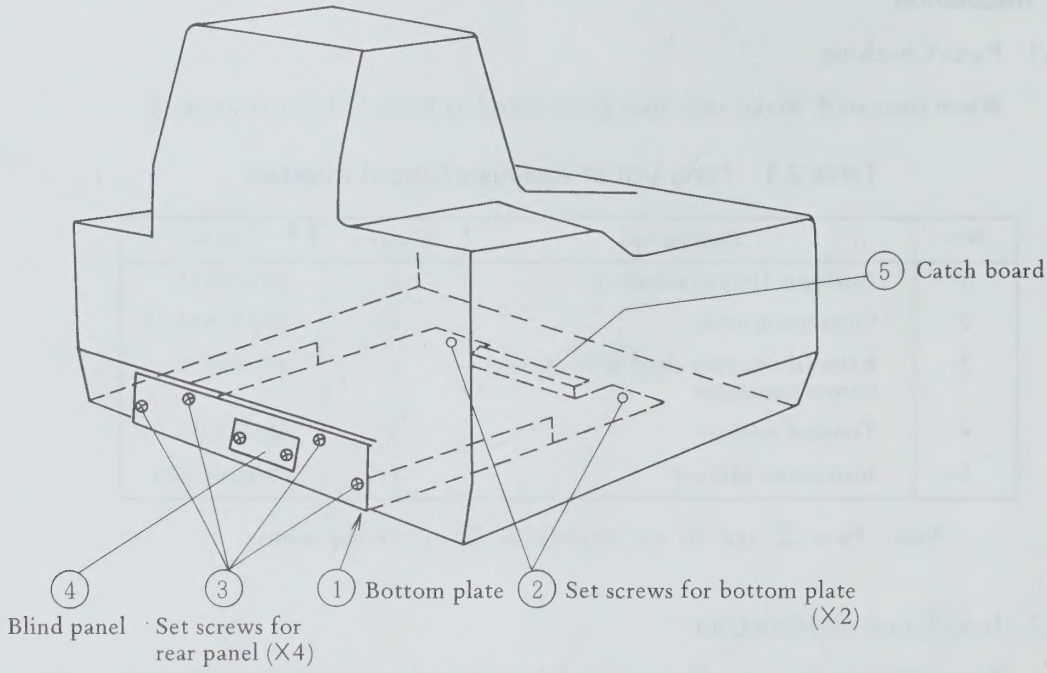
Turn OFF the power switch of the UV-160, and mount the interface through the following procedures in reference to Fig. 2.1.

(1) Remove set screws for the bottom plate (Fig. 2.1 (a) ①) carrying the CPU board at the bottom of the UV-160, and pull out the bottom plate, as shown in Fig. 2.1 (b). For this, first displace the UV-160 toward the operator on the table as shown in Fig. 2.1 (a), and remove 2 set screws for the bottom plate and 4 set screws for the rear panel (Fig. 2.1 (a) ② and ③). The bottom plate falls on to the desk. Pull it gently backward, until the interface mounting connector at the middle of the printed circuit board (Fig. 2.1 (b) ①) becomes accessible.

(2) Remove the blind panel (Fig. 2.1 (a) ④) at the interface board mounting position, and mount the interface board, using furnished toothed washers in place of plastic washers used for fastening the blind panel (Fig. 2.1 (b)).

(3) Connect the flat cable connector (Fig. 2.1 (b) ②) to 26-pin connector C6 on the CPU board (Fig. 2.1 (b) ①), with the cable twisted once. (Owing to the presence of misconnection preventing process, the connector can be inserted only in this orientation.)

(4) Put the bottom plate gently in from the rear, with the leading edge slightly lifted so that the catch board (Fig. 2.1 (a) cross section ⑥) of the bottom plate engages with the front base (Fig. 2.1 (a) cross section ⑦). Then, fasten 4 set screws for the rear panel and 2 set screws for the bottom plate (Fig. 2.1 (a) cross section ⑧ and ⑨).



Cross-section

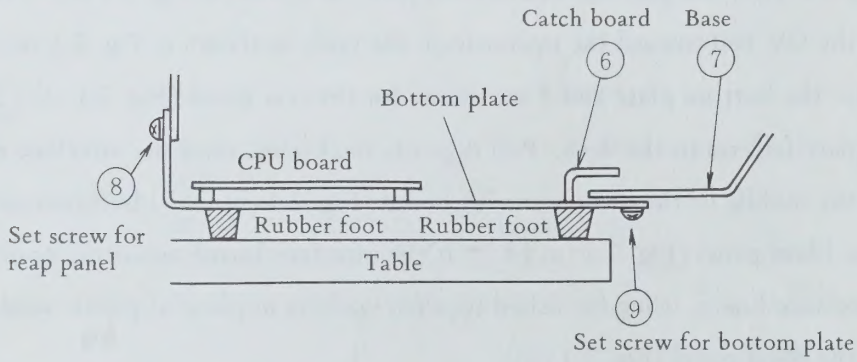


Fig. 2.1 (a) Mounting of Bottom Plate

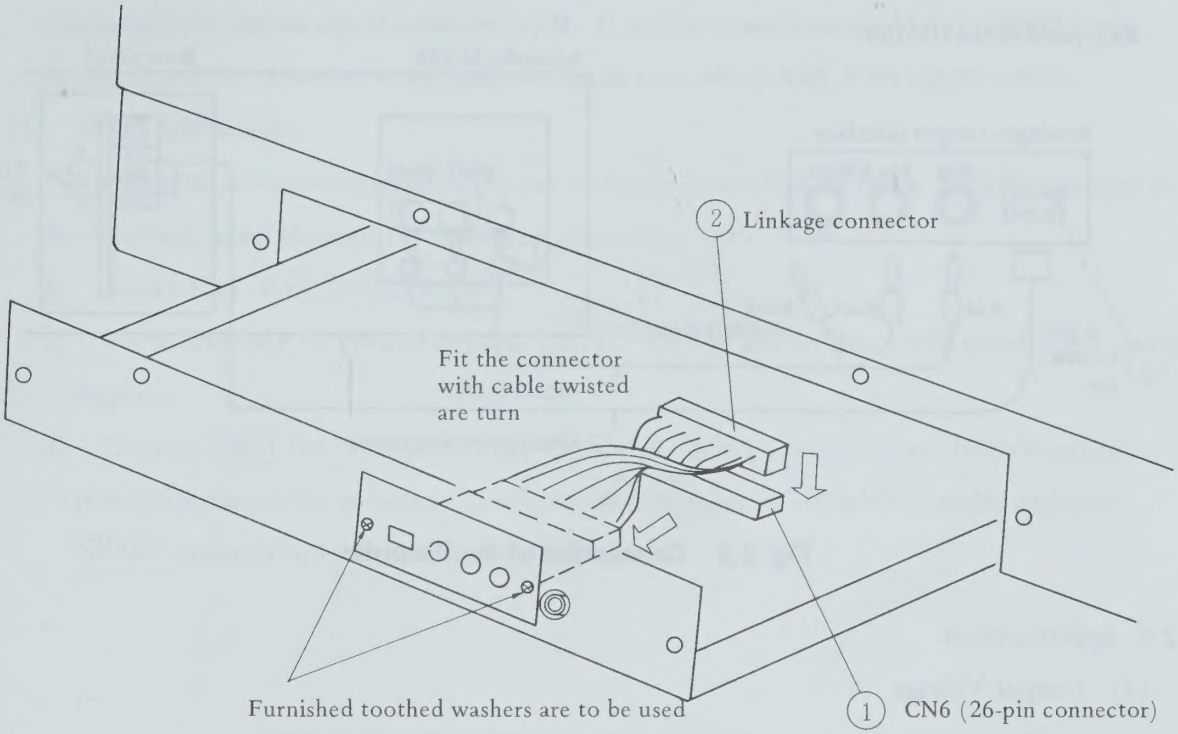


Fig. 2.1 (b) Mounting of Interface

2.3 Connection

Fig. 2.2 shows the connection of the UV-160 with a strip chart recorder U-135 (P/N 200-91513). Since the U-135 requires 100V, 30VA, the power can be supplied from the AC outlet at the rear of the UV-160 (up to 40VA). The Analog Outlet Interface is provided with three connection terminals: red (+), black (-) and black (GND), to which three wires (+) (-) and shielding sheath of the recorder signal cable are to be connected, respectively. Terminals (-) and GND are connected by a short-circuiting board.

Any recorder other than the U-135 can be connected in the same way as described in the above.

A two-pin connector (Fig. 2.2 ①) beside the terminals provides the contact signal to synchronize the start of the U-135 chart drive with that of the UV-160 measurement. Two pins of the connector are short-circuited within the UV-160 in synchronization with the start of measurement.

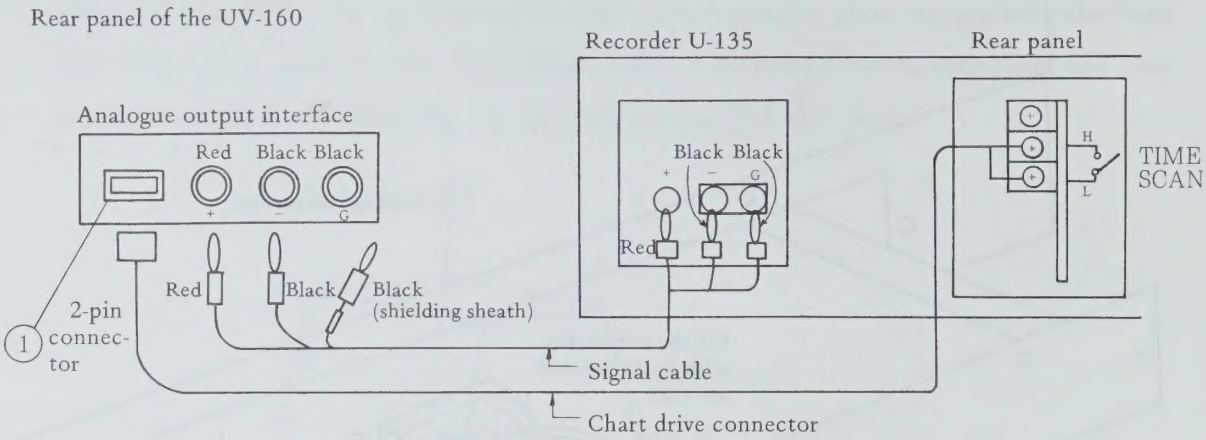


Fig. 2.2 Connection of the Recorder

2.4 Specifications

(1) Output Voltage

Mode	Output Voltage	Maximum Output Voltage
ABS	±100mV for ±2 ABS	saturated at ±2.25 ABS
T%	±100mV for ±100%	saturated at ±112.5%
ABS×10	±100mV for ±0.2 ABS	saturated at ±0.225 ABS

Note: The output voltage can be finely controlled by the method described in (6).

(2) Signal Output Timing for EXT. REC. SPECTRUM

In "ABS" mode ..... output at every 0.1nm

In "T%" mode ..... output at every 0.2nm

(3) Signal Output Timing for EXT. REC. TIME SCAN

In "ABS" mode ..... output at every 50ms

In "T%" mode ..... output at every 110ms

(4) Capacity of Contact Output

An external load up to AC100V, 0.2A (or DC24V, 0.3A) can be connected.

(5) Others

The analog output signal is 0V until the mode for (2) or (3) is initiated, and NO is depressed for "PARAMETER CHANGE Y/N?". When NO is depressed, an analogue output corresponding to the photometric reading on the CRT will appear on the recorder.

If ABS X 10 GAIN is set to YES, AUTO ZERO is actuated as soon as the measurement starts, and the output signal starts from 0V. If not in measurement, AUTO ZERO is not actuated and the situation is the same as that in case where ABS X 10 GAIN is NO.

(6) SPAN Adjustment

The output voltage described in (1) can be finely controlled by using [SPAN] trimmer on the interface panel through the following procedure.

1) Select EXT. REC. SPECTRUM.

2) Set MEASURE to T% and depress [AUTO ZERO] key so that 100% is indicated on the display.

3) Depress [NO] for "PARAMETER CHANGE Y/N?". In this state, 100mV output should appear on the recorder. If not, set the recorder to 100mV full scale, and turn [SPAN] trimmer until the pen points full scale.

3. Operational Procedures

When [9] [ENTER] are depressed for the basic mode select menu, a display shown in Fig. 3.1 appears on the CRT.

```
OPERATION No.="1"?
-------------------------------------------
1.SIPPER
2.EXT. REC. SPECTRUM
3.EXT. REC. TIME SCAN
4.CPS DATA PRINT
5.CPS KINETIC
```

Fig. 3.1 Operation Select Menu in the ATTACHMENT Mode.

3.1 Operational Procedures for EXT. REC. SPECTRUM Mode

When [2] [ENTER] are keyed in, the EXT. REC. SPECTRUM mode sets in to display the PARAMETER CHANGE menu. Description of each parameter is given in Table 3.1.

```
EXT.REC.        PARAMETER CHANGE Y/N ?
-------------------------------------------
1.λS= 800.0NM     λE= 400.0NM
2.MEASURE(ABS/T%)=ABS
3.SCAN SPEED(100,120NM/MIN.)=100NM/MIN.

11:12  8/09 '85                 800.0NM   0.000A
```

Fig. 3.2 Parameter Change Menu for EXT. REC. SPECTRUM Mode.

Table 3.1 Description of Parameters in EXT. REC. SPECTRUM Mode.

Item (Setting Range)	Description
1. λ_S, λ_E [200 ~ 1100] $\lambda_S - \lambda_E \geqq 10.0$	λ_S: start wavelength, λ_E: end wavelength Minimum wavelength range is 10nm.
2. MEASURE [ABS, T%]	To select the photometric mode: absorbance (ABS) or transmittance (T%).
3. SCAN SPEED [100, 120 NM/MIN]	To select the wavelength scan speed. When recording on an external recorder, the scan speed is set relatively slow in consideration of recorder pen respense. In case of the U-135 recorder, the chart feed speed varies depending upon the line frequency: 100 NM/MIN for 50Hz area and 120 NM/MIN for 60Hz area.

If keyed [NO] [START/STOP] for "PARAMETER CHANGE Y/N?", the measurement starts, and the absorption spectrum data are output to the external device. The CRT display remains to be the parameter change menu, and no spectrum is displayed. The progress of measurement is to be found in reference to the wavelength reading at the bottom right of the CRT. If [START/STOP] is depressed again, the measurement stops and the wavelength is reset to λ_S.

In order to return to the basic mode select menu, depress [RETURN] until the operation select menu in the ATTACHMENT mode appears. (Usually, the display shown in Fig. 3.1 is restored when [RETURN] is depressed twice.) If [MODE] is depressed after the display returned to show the menu shown in Fig. 3.1, the basic mode select menu appears.

3.2 Operational Procedures for EXT. REC. TIME SCAN

If [3] [ENTER] is selected for the operation select menu of Fig. 3.1, the system turns to the EXT. REC. TIME SCAN mode, bringing the parameter change menu shown in Fig. 3.3 on to the display. Description of each parameter is given in Table 3.2.

```
EXT.REC.        PARAMETER CHANGE Y/N ?

        1.λ= 800.0NM
        2.MEASURE(ABS/T%)=ABS
        3.ABS X10 GAIN  NO


11:13  8/09 '85                    800.0NM   0.000A
```

Fig. 3.3 Parameter Change Menu for the EXT. REC. TIME SCAN Mode

Table 3.2 Description of Parameters for EXT. REC. TIME SCAN Mode

Item (Range)	Description
1. λ [200 ~ 1100]	To set the measuring wavelength at 0.1nm increment.
2. MEASURE [ABS, T%]	To select the photometric mode, either absorbance (ABS) or transmittance (T%).
3. ABS X 10 GAIN [YES, NO]	When set to YES, the photometric gain for the absorbance is increased by 10X. The minimum increment for the ordinate full scale is 0.001 Abs. When set to YES, the AUTO ZERO is set as the measurement starts, and the initial value is automatically set to 0. The measurable absorbance range is about -0.225 ~ +0.225 Abs. When the measurement is finished, Auto Zero is turned off and the original measurement value is restored. If set to NO, AUTO ZERO is not made.

If keyed [NO] [START/STOP] for "PARAMETER CHANGE Y/N?", the measurement starts. The measured data are sent out to the external device. The parameter change menu remains on the CRT, and none of time change curves are displayed. The cursor at the bottom right flashes to indicate that the measurement is being made. If [START/STOP] is depressed again, the measurement is halted.

To return to the basic mode select menu, depress RETURN until the operation select menu for the ATTACHMENT mode shown in Fig. 3.1 appears. Usually, it is necessary to depress RETURN twice. If MODE is depressed after the display returned to Fig. 3.1, the basic mode select menu is restored.

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SHIMADZU CORPORATION

KYOTO JAPAN

INSTRUCTION MANUAL

CPS-240A
CELL POSITIONER
(P/N 204-05837-01)

FOR

UV-160, UV-240/250, MPS-2000

SHIMADZU

INSTRUCTION MANUAL

CPS-240A
CELL POSITIONER
(P/N 204-05837-01)
FOR
UV-160, UV-240/250, MPS-2000

SHIMADZU CORPORATION
SPECTROPHOTOMETRIC INSTRUMENTS PLANT
ANALYTICAL INSTRUMENTS DIVISION
KYOTO, JAPAN

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1. Introduction

This attachment is used to insert 6 cells automatically into the optical path in turn at regular intervals, in order to measure efficiently the time-course variation of absorbance caused by chemical changes such as enzymatic reaction.

This attachment employs a unique heat exchange system with heat pipe which is electronically thermo-controlled, thus insuring a high-accuracy temperature control over a wide temperature range without circulating cooled water.

To connect this attachment to Spectrophotometer UV-240/250, Optional Unit OPI-4 is necessary. Additionally, to connect this attachment to the MPS-2000, Optional Unit OPI-2014 required.

No interface is required when the CPS-240A is used in combination with the UV-160.

2. Installation

2.1 Inspection of Parts

Confirm that the following parts are all contained.

Table 2.1 Standard Contents

No.	Description	Qt.	Part No.	Remarks
1	Sample compartment unit	1	204-03961-01	
2	CPS controller	1	204-03725-03	
3	Connecting cable	1	200-79883-01	
4	S cell holder's lid	1	204-05830-02	
5	Power cable with plug	1	200-81008-01 200-81008-02	For 100~120V power line For 200~240V power line
6	Fuse	2	072-01025 072-01003	2A for 100~120V power line 1A for 200~240V power line
7	Instruction manual	1	CME101-470	

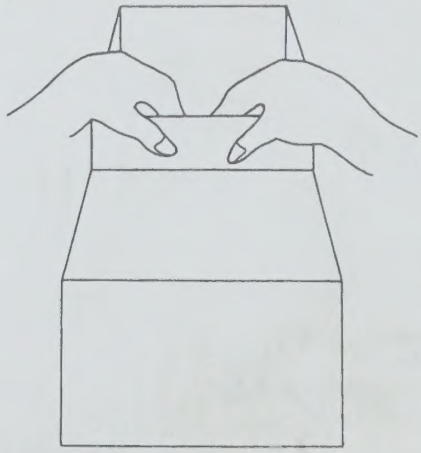
2.2 Installation

(1) Assembly

(a) When Combined with UV-160

Remove the standard sample compartment unit from the UV-160 by pulling the unit upward and toward the operator. Set the sample compartment unit of the CPS-240A in its place. Push the sample compartment unit fully in so that V-notch on the unit is securely engaged with the inner positioning pin in the compartment. Then, make the dowel at the bottom of the sample compartment unit fit into the outer positioning pin hole. (See Fig. 2.1.)

Caution: When mounting and dismounting of the sample compertment unit, hold the unit as shown in the figure.



(b) When Combined with UV-240/250

The sample compartment unit for the CPS-240A is to be used with a dowel at its bottom removed by using a screw-driver (Fig. 2.1). Remove the standard sample compartment unit of the UV-240/250 by loosening two sample compartment unit set screws at the front bottom of the UV-240/250 Spectrophotometer main unit and pulling the unit upward and toward the operator. Set the sample compartment unit for the CPS-240A in its place. Push the sample compartment unit fully in so that V-notch on the unit is securely engaged with the inner positioning pin of the compartment, and then, make the sample compartment unit fit to the outer positioning pin. Finally, fasten two set screws to finish the installation work.

It should be noted that if pins fail to engage securely in the inner V-shaped notch, the unit does not fit to the outer pins.

(c) When Combined with MPS-2000

The sample compartment unit for the CPS-240A is to be used with a dowel at its bottom removed by using a screw-driver (Fig. 2.1). Loosen set screws (13) for the shading plate (12) and remove the shading plate, refering to Fig. 4.1. Set screws (13) are to be installed so as to prevent the light from leaking out of the screw holes. Then, remove the front and bottom plates of the sample compartment of the MPS-2000, in reference to Paragraph 4.4 of the Instruction Manual for the MPS-2000.

Set the sample compartment unit for the CPS-240A, by pushing the unit fully in so that the inner positioning pin of the compartment is securely engaged with the V-shaped notch of the sample compartment unit, and then, making the outer positioning pit fit. Fasten two set screws to finish the installation work. Finally, set the front plate fixing metals on both sides.

It should be noted that if pins fails to engage securely in the inner V-shaped notch, the unit does not fit to two pins.

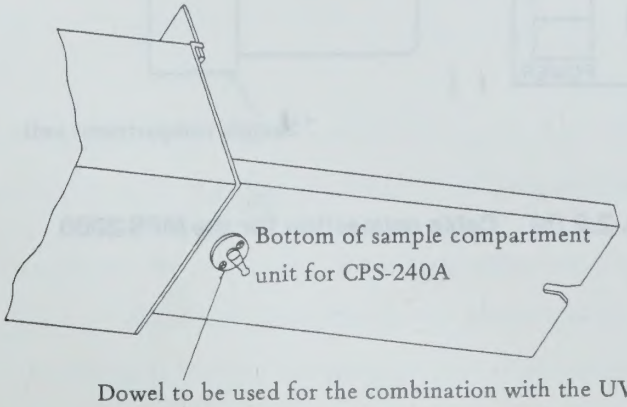


Fig. 2.1 Position of Dowel

(2) Connect the spectrophotometer and the cell positioner according to Fig. 2.2.

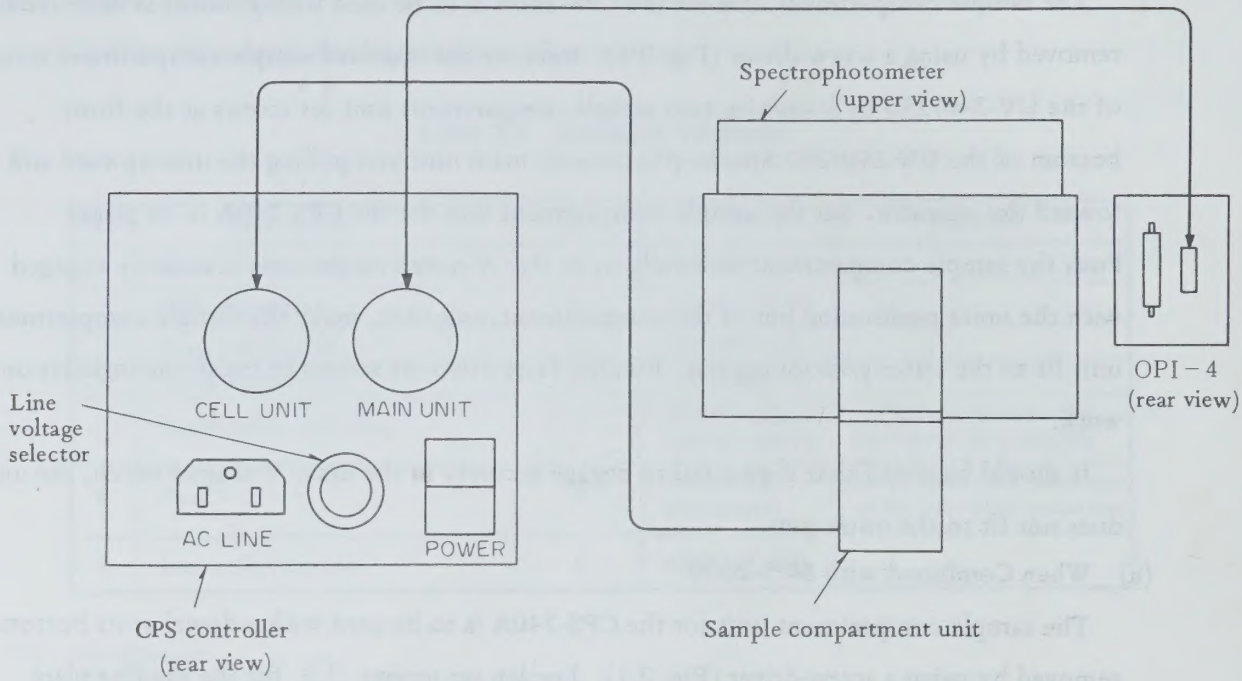


Fig. 2.2 (a) Cable connection for the UV-240

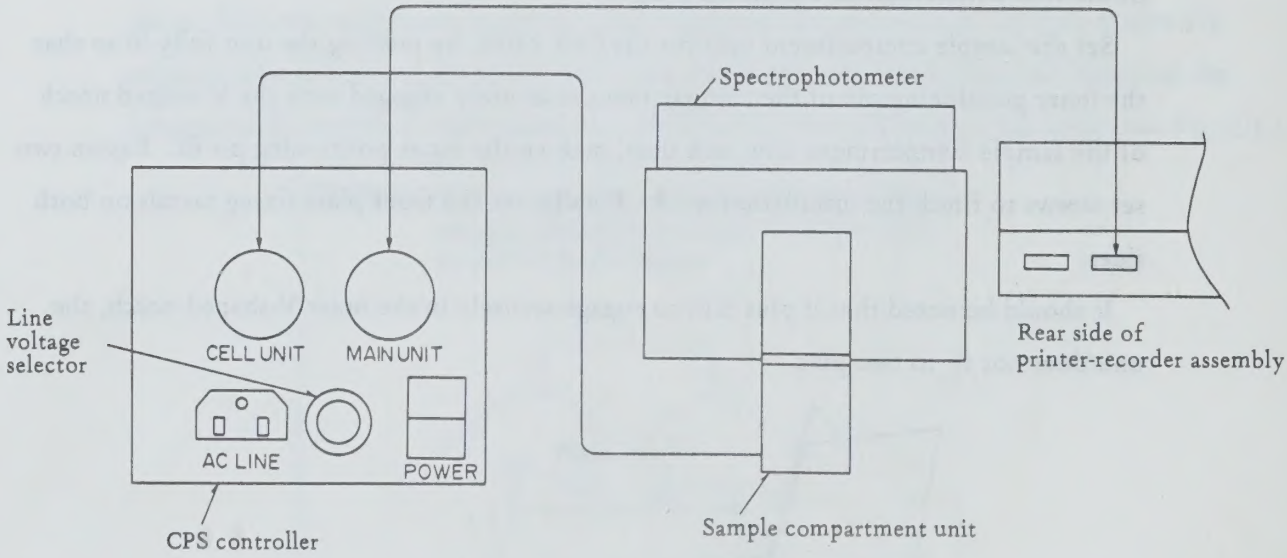


Fig. 2.2 (b) Cable connection for the MPS-2000

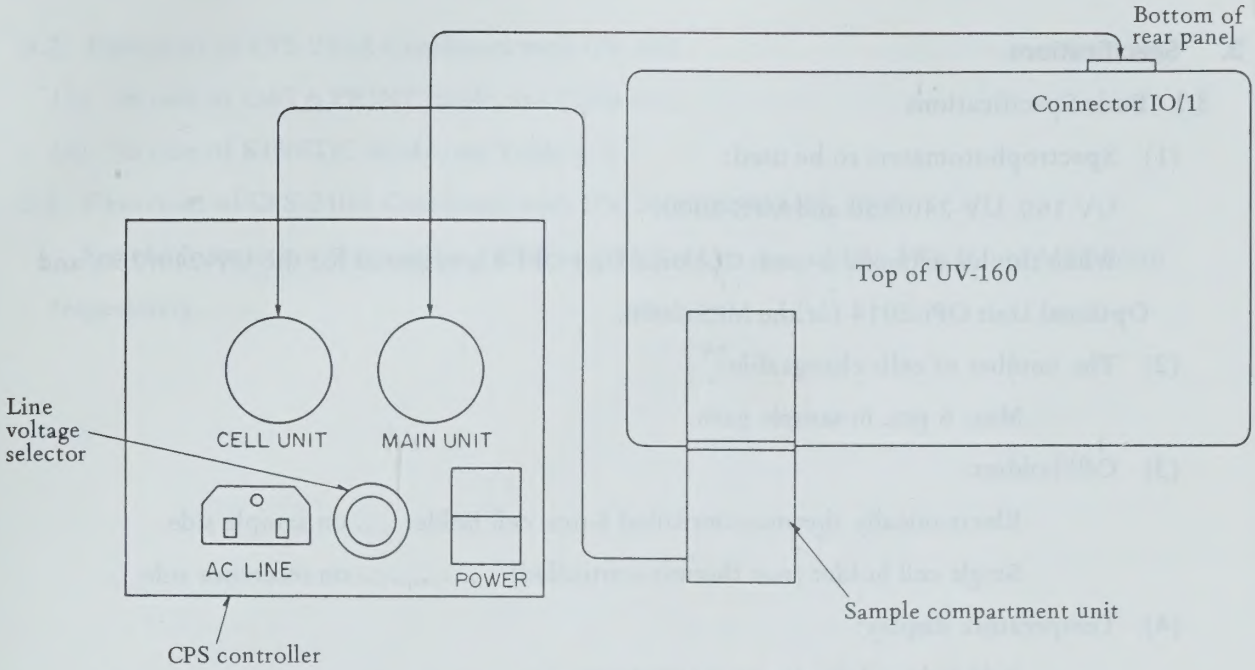


Fig. 2.2 (c) Cable connection for the UV-160

(3) The line voltage is selectable in 4 steps; 110V, 117V, 220V and 240V. A line voltage selector is provided on the rear side of CPS controller, as shown in Fig. 2.2. To select the line voltage, first pull out the fuse holder lid by counterclockwise rotation, and then properly set the line voltage selecting terminal. In the case of 220 ~ 240V, exchange the fuse for 1A one (rated voltage: AC 250V).

3. Specifications

3.1 Basic Specifications

(1) Spectrophotometers to be used:

UV-160, UV-240/250 and MPS-2000.

When this attachment is used, Optional Unit OPI-4 is required for the UV-240/250, and Optional Unit OPI-2014 for the MPS-2000.

(2) The number of cells changeable:**

Max. 6 pcs. in sample path.

(3) Cell holders:

Electronically thermo-controlled 6-pcs. cell holder ..... on sample side.

Single cell holder (not thermo-controlled) ..... on reference side.

(4) Temperature display:

3-digit digital display in 0.1°C divisions.

(5) Manual cell change:

The cell position can be changed step by step manually with the step switch.

(6) Operating temperature and humidity:

Room temperature 15°C to 35°C; humidity 45% to 80%. When the room temperature is higher than 30°C, the humidity is to be held at 70% or lower.

(7) Temperature control range:*

16 ~ 60°C

(8) Temperature accuracy*(difference between true value and indication):

±0.5°C

(9) Temperature control precision*(variations of temperature indication):

±0.1°C

(10) Power requirements:

AC100, 117 (115), 220, 240V selectable on a voltage selector; 50/60Hz in common.

(11) Dimensions:

CPS controller ..... 160mm width, 420mm depth and 140mm height

Sample compartment unit .... 120mm width, 470mm depth and 155mm height

* The temperature detector is attached to the cell holder, and therefore the temperature indication does not show exactly the temperature in the cell.

For the relation between the preset temperature and cell temperature, refer to Figs. 4.7 to 4.9.

** A photometric difference at cell switching is within 100 % T ± 0.2% T.

3.2 Functions of CPS-240A Combined with UV-160

(1) In case of DATA PRINT mode, see Table 4.1.

(2) In case of KINETIC mode, see Table 4.2.

3.3 Functions of CPS-240A Combined with UV-240/250 or MPS-2000.

See the Instruction Manuals for OPI-4 or OPI-2014 in case of UV-240/250 or MPS-2000, respectively.

4. Operation

4.1 Description of Each Part (refer to Fig. 4.1)

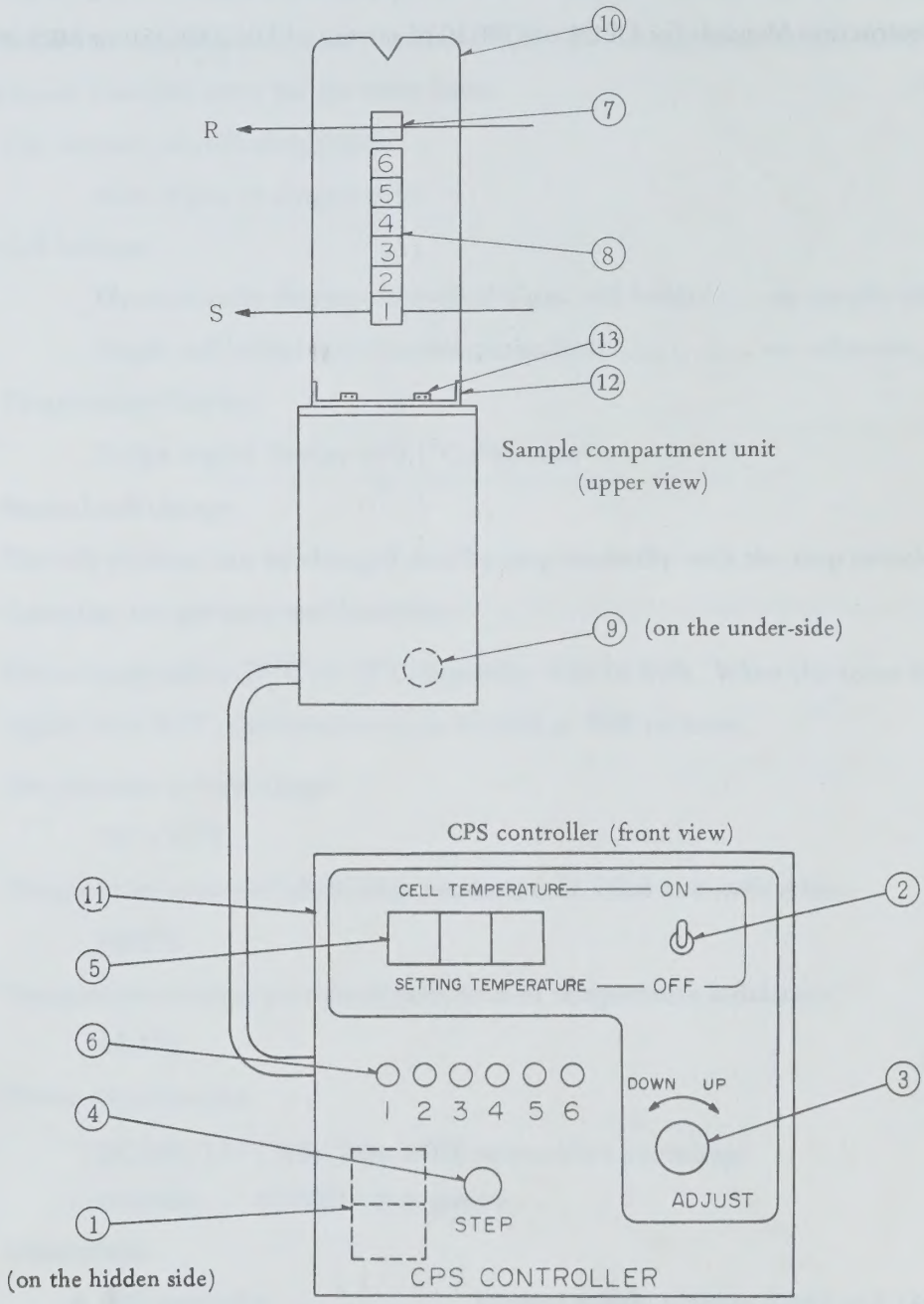


Fig. 4.1 Description of Each Part

No. in Fig. 4.1	Description	Function
①	Power switch	Turn to the upper side to turn on the power, to the lower to turn off the power.
②	Temperature control switch	In "ON" position, temperature control is made, and the temperature display indicates the cell holder temperature. Whereas, in "OFF" position, temperature control is not made, and the temperature display indicates merely the desired preset temperature.
③	Temperature adjuster	Counterclockwise turn decreases the desired preset temperature, and clockwise turn increases the temperature.
④	Step swtich	Used to advance the cell position manually step by step.
⑤	Temperature display	Indicates the cell holder temperature or the preset temperature (temperature adjuster setting).
⑥	Cell position display	Indicates the cell position.
⑦	Reference cell holder	
⑧	Sample cell holder	
⑨	Dry air inlet	Used to introduce dry air so as to prevent dews from being produced on the cell in the case of lower temperature control.
⑩	Sample compartment unit	
⑪	CPS controller	
⑫	Shading plate	Not used for the MPS-2000
⑬	Shading plate set screw	

4.2 Operating Procedure

4.2.1 Operation of Cell Positioner Alone

(1) After finishing the installation and connection (refer to the section 2.2), turn on the power switch on the CPS controller. Then, the cell position display indicates that the cell No. 1 is inserted in the optical path. After that, turn on the power switch on the spectrophotometer, and wait until the initialization is finished.

Note: It is permissible to turn on the CPS controller power switch after turning on the power switch on the spectrophotometer. In this case, avoid turning on and off the CPS controller power switch in a short time, or the spectrophotometer should faultily start measurement automatically.

(2) Temperature

When the temperature control switch is turned off, the temperature display indicates merely the desired pre-set temperature, not the cell temperature. The desired pre-set temperature can be decreased by turning the temperature adjuster counterclockwise, and increased by turning it clockwise. After pre-setting the desired temperature as required, turn on the temperature control switch; then, the cell temperature is controlled at the preset desired temperature. Any temperature setting over 70°C, is regarded as 70°C.

(3) Temperature Control

The temperature control is started by turning on the temperature control switch.

- When the temperature control switch is turned off, the temperature control is stopped, and the status comes to the temperature setting mode.
- The temperature adjuster does not work during the temperature control mode.
- If the power switch is turned on with the temperature control switch left in "ON", the set temperature will be regarded as 20°C.

(4) Manual Drive of Cells

The cell position can be advanced step by step by pressing the step switch. The cell No. 6 is followed by the cell No. 1.

4.2.2 Operation in Combination with the UV-240/250 or the MPS-2000

There are two linkage programs with the spectrophotometer; Data Print Program and Kinetic Program. For the details, refer to OPI-4 and OPI-2014 Instruction Manuals.

Additionally, the cell position can be controlled by the external device like a personal computer through the spectrophotometer. For the details, refer to OPI-4 or OPI-2014 Instruction Manual.

4.2.3 Operation in Combination with the UV-160

The Spectrophotometer UV-160 combined with the Cell Positioner CPS-240A is operated in either of the following two modes:

(1) CPS DATA PRINT mode.

(2) CPS KINETIC mode.

4.2.3.1 CPS DATA PRINT Mode

In this mode, the absorbance (or transmittance) of each cell is measured at a certain time interval. The system allows not only the simple measurement at a fixed wavelength, but also data processing for 2-/3-wavelength, 4-data calculation, and 5-wavelength measurement. For details of data processing, see Paragraph 4.3 in the Instruction Manual for

the UV-160. It should be noted, however, in case of 4-data calculation, as 4 data are measured consecutively for a single cell, the sample can not be changed while 4 data, A1~A4, are being measured. An example of operation in the CPS DATA PRINT mode is shown in Fig. 4.2.

CYCLE N= 1

λ	800.0	750.0	700.0	650.0	600.0
CELL	A1	A2	A3	A4	A5
1	0.780	0.719	1.385	1.506	1.224
2	0.687	0.615	1.256	1.320	1.015
3	0.044	-0.002	0.634	0.693	0.316
4	1.048	0.984	1.662	1.821	1.558

CYCLE N= 2

λ	800.0	750.0	700.0	650.0	600.0
CELL	A1	A2	A3	A4	A5
1	0.780	0.719	1.386	1.506	1.225
2	0.764	0.690	1.326	1.381	1.075
3	0.050	0.008	0.649	0.714	0.343
4	1.049	0.984	1.663	1.822	1.560

CYCLE N= 3

λ	800.0	750.0	700.0	650.0	600.0
CELL	A1	A2	A3	A4	A5
1	0.781	0.720	1.387	1.507	1.227
2	0.761	0.683	1.307	1.365	1.048
3	0.157	0.118	0.765	0.829	0.461
4	1.078	1.019	1.702	1.865	1.607

Fig. 4.2 Example of Operation in the CPS DATA PRINT mode (5-wavelength measurement)

When the system is set to the CPS DATA PRINT mode, a display shown in Fig. 4.3 appears first on the CRT. The parameters are described in Table 4.1.

```
CPS D.PRINT   PARAMETER CHANGE Y/N ?

  1.GOTO λ= 800.0NM        λ1   800.0
  2.MEASURE(ABS/T%)=ABS
  3.CELL N=6
  4.CYCLE T=  60SEC
          N= 1
  5.PROCESSING=1λ

  6.BLANK

21:36  1/14 '85                    800.0NM  -0.000A
```

Fig. 4.3 Display for Parameter Change in the CPS DATA PRINT mode

Table 4.1 Description of Parameters for CPS DATA PRINT Mode

Parameter (Setting Range)	Description		
1. GO TO λ [200 ~ 1100nm]	To be used for shifting the wavelength to any position, independently from the measuring wavelengths ($\lambda_1 \sim \lambda_5$).		
2. MEASURE [ABS, T%]	To specify the photometric conditions, absorbance (ABS) or transmittance (T%). In case of PROCESSING = 2λ, 3λ and 4D, the parameter is set to ABS, irrespectively of setting.		
3. CELL N [1 ~ 6]	To specify the number of cells to be measured.		
4. CYCLE T [0 ~ 9999] CYCLE N [1 ~ 99]	The cycle time T represents the time interval from n-th to (n+1)-th measurement for each cell. If time required for one whole cycle is longer than T setting, the next cycle starts immediately after the previous cycle. Time for one whole cycle depends on the number of cells and wavelengths (for multi-λ). It requires for example 25 seconds in the single wavelength mode for 6 cells. CYCLE N represents the number of cycles. If no repetition is required, set N=1. When PROCESSING=4D, N is automatically set to N=1.		
5. PROCESSING [1λ, 2λ, 3λ, 4D, 5λ]	PROCESSING	Contents	Required Parameter
	1λ	Normal measurement at a single fixed wavelength	λ_1
$\lambda_1 \sim \lambda_5$ [200 ~ 1100]	2λ	Two-wavelength calculation	λ_1, λ_2
	3λ	Three-wavelength calculation	$\lambda_1, \lambda_2, \lambda_3$ ($\lambda 1 > \lambda 2 > \lambda 3$)

Parameter (Setting Range)	Description		
	PROCESSING	Contents	Required Parameter
$K_1 \sim K_5$ [0.0001~9999.9] (Zero and negative value is permissible)	4D	Four-data calculation by either of two expressions: $(K_1A_1 + K_2A_2 + K_3A_3 + K_4A_4) * K_5$ or $[(K_1A_1 + K_2A_2)/(K_3A_3 + K_4A_4)] * K_5$	$\lambda_1 \sim \lambda_4$ $K_1 \sim K_5$
	5λ	Five-wavelength measurement	$\lambda_1 \sim \lambda_5$
6. BLANK	To be selected when AUTO ZERO is required for each cell		
(7. EXTERNAL START)	Use it at NO except when a special attachment is connected.		

Operating Procedures

How to Read "Operating Procedures"

- If the column for the next step has no entry, this means that operation proceeds according to the sequence.
- Figures in square brackets under [Numerical Value] show the input enable range.

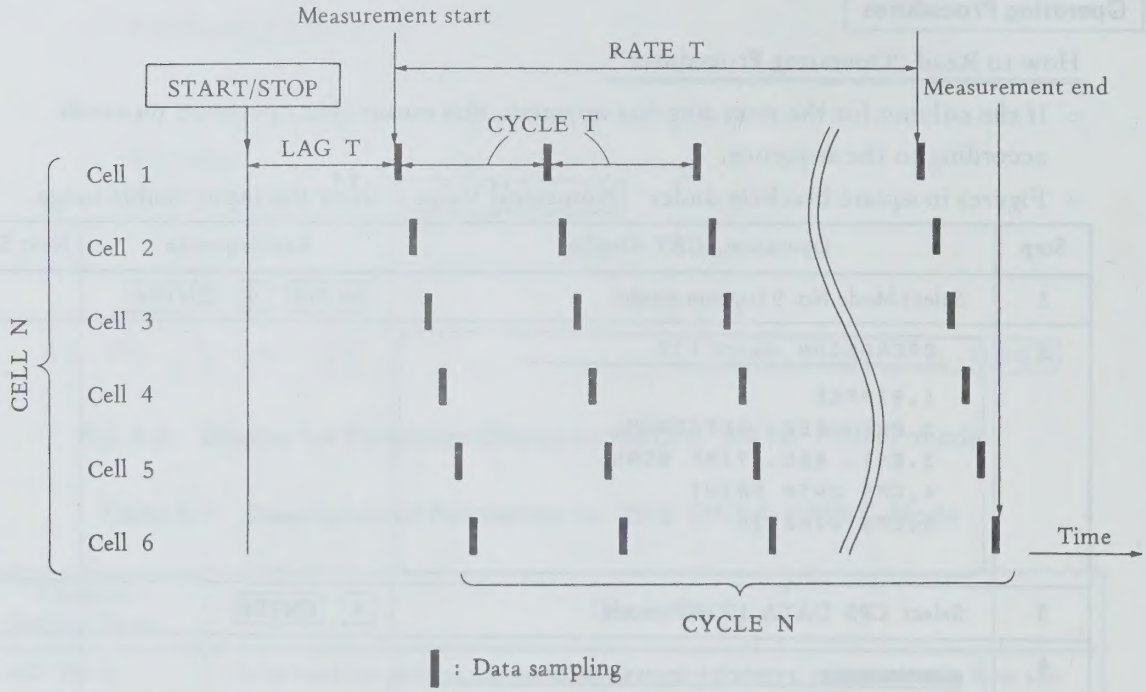
Step	Operation, CRT Display	Key Sequence	Next Step
1	Select Mode No. 9 (option mode)	[MODE] [9] [ENTER]	
2	OPERATION No.="1"? 1.SIPPER 2.EXT. REC. SPECTRUM 3.EXT. REC. TIME SCAN 4.CPS DATA PRINT 5.CPS KINETIC		
3	Select CPS DATA PRINT mode	[4] [ENTER]	
4	CPS DATA PRINT PARAMETER CHANGE Y/N ? 1.GOTO λ= 800.0NM λ1 800.0 2.MEASURE(ABS/T%)=ABS 3.CELL N=6 4.CYCLE T= 60SEC N= 1 5.PROCESSING=1λ 6.BLANK (7.EXTERNAL START NO) Usually use at NO for a instrument which displays "EXTERNAL START".*		
5	Set parameters	See Paragraph 4.2.1 in Instruction Manual for UV-160.	
6	Start operation	[START/STOP]	
7	End When pressing [START/STOP] key, the next measurement starts (to Step 6). When pressing [RETURN] key, the operation returns to step 4. If [RETURN] key is pressed again, the operation returns to step 2. Pressing [MODE] key here produces the basic mode menu display.		

*Remark: Prepared for attachments. With EXTERNAL START "YES", one whole cell-positioner cycle can be externally started by a signal through the connector I/O a of the UV-160.

4.2.3.2 CPS KINETIC Mode

The absorbance is measured for each cell at certain time interval to draw a time change curve. The rate of absorbance change per minute is determined by the method of least square, and multiplied by FACTOR value to obtain ACTIVITY. It is possible to output absorbance values at certain time interval and rate of absorbance change. Blank for each cell (auto zero) or absorbance difference from cell 1 (reagent blank) is also available.

Terms used in the CPS KINETIC mode are described in Fig. 4.4.



1. Cell Number (CELL N)
   The number of cells to be measured. The measurement starts always from Cell 1 (the cell at the frontmost).
2. Lag Time (LAG T)
   Time interval from pressing START/STOP key to starting the measurement.
3. Time Interval between Measurements (CYCLE T)
   Time interval from n-th to (n + 1)-th measurement for each cell.
4. Number of Repetitions (CYCLE N)
   The number of repeated measurements for each cell.
5. Factor (FACTOR)
   The factor to be multiplied to the rate of absorbance change per minute for each cell as obtained by the method of least square, to calculate the activity value.
   ACTIVITY = FACTOR × RATE OF ABSORBANCE CHANGE (ΔA/min)
6. Rate Measuring Time (RATE T)
   Defined as (CYCLE T) × (CYCLE N − 1).

Fig. 4.4 Description of Terms Used for CPS KINETIC Mode

An example of measurement in the CPS KINETIC mode is shown in Fgi. 4.5, which concerns the measurement of the GPT (ALT) activity. Items enclosed in parentheses ( ) are displayed in case of making reagent blank correction. In the latter case, ABS (CORR) calculates:

(ABS of Cell n) − {(ABS of Cell 1) − (ABS of Cell 1 in 1st measurement)} .

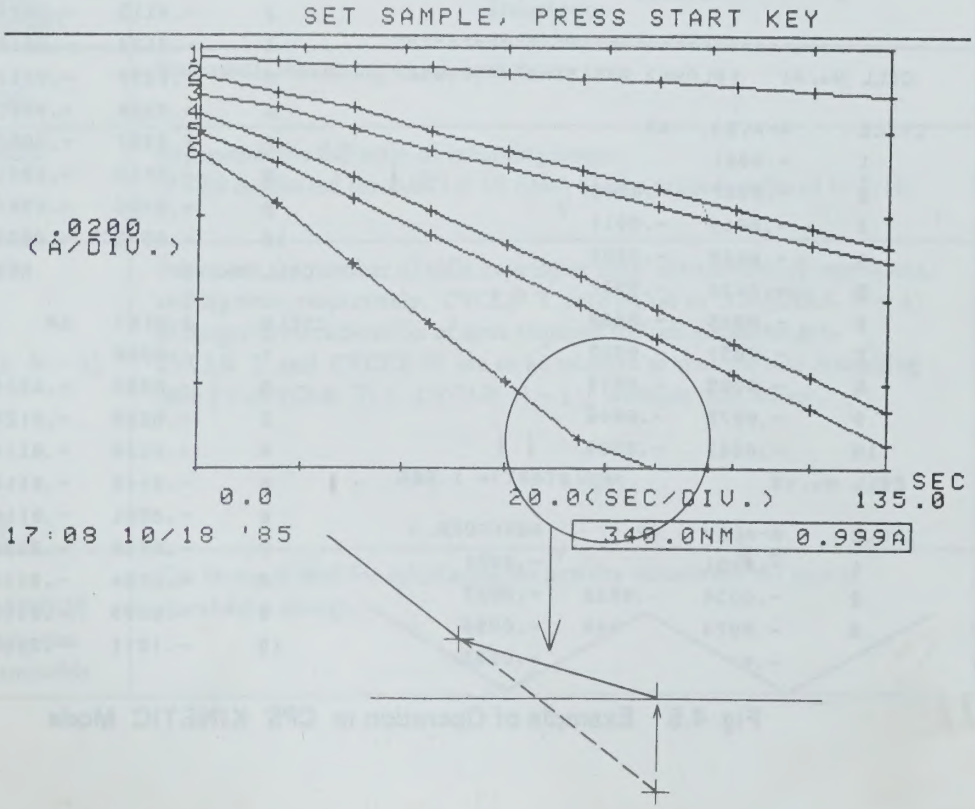
The rate of absorbance change and activity value for each cell can be obtained by using this value.

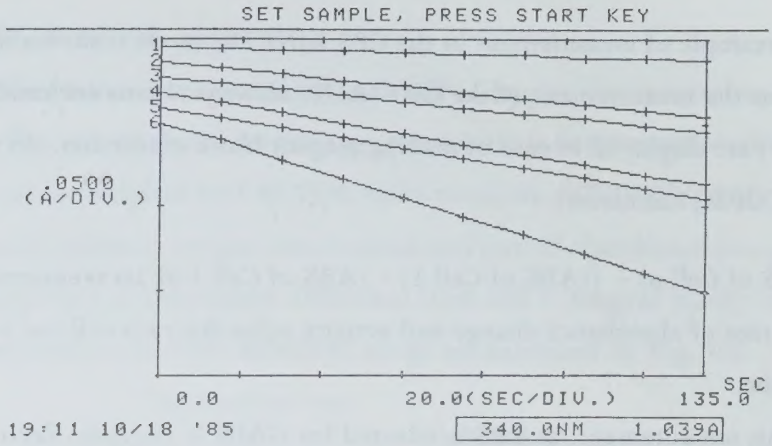
In this measurement, as YES is selected for GAIN X 10, Auto Zero is made immediately before starting the first measurement for each cell. For this reason, whenever YES is selected for GAIN X 10, the absorbance value before taking Auto Zero is displayed as ABS (START) = .

In the time change curve displayed on the CRT, the start points are fixed at positions slightly shifted for different cells.

As the CPS KINETIC mode starts, a display as shown in Fig. 4.6 appears on the CRT. Descriptions of various measurement parameters are given in Table 4.2.

NOTE 2 When a measurement point goes out of the display area, that point is forcibly shifted on to the upper or lower limit (see the figure below). For this reason, it should be noted that a linear curve is displayed as bent, while measured values and calculation results are correctly printed.





*** CPS KINETIC ***

LAG T= 10SEC RATE T= 135SEC

CELL No.	dA/MIN. (CORR.)	ACTIVITY (CORR.)
1	0.0000	0.0000
2	-0.0108	-23.097
3	-0.0107	-23.021
4	-0.0209	-44.735
5	-0.0208	-44.544
6	-0.0418	-89.657

CELL No.=1 (BLANK) ABS(START)= 1.052

CYCLE	A-A(S)	dA
1	-.0001	
2	-.0007	-.0006
3	-.0019	-.0011
4	-.0028	-.0009
5	-.0036	-.0007
6	-.0045	-.0009
7	-.0051	-.0005
8	-.0065	-.0014
9	-.0072	-.0006
10	-.0081	-.0008

CELL No.=2 ABS(START)= 1.080

CYCLE	A-A(S)	dA	ABS(CORR.)
1	-.0001		-.0001
2	-.0034	-.0032	-.0027
3	-.0074	[illegible]	-.0056
[illegible]	[illegible]		-.0083
3	[illegible]	-.0061	
4	.0181	-.0062	[illegible]
5	-.0243	-.0062	-.0208
6	-.0308	-.0064	-.0264
7	-.0368	-.0060	-.0318
8	-.0428	-.0060	-.0364
9	-.0490	-.0062	-.0419
10	-.0545	-.0055	-.0466

CELL No.=5 ABS(START)= 1.126

CYCLE	A-A(S)	dA	ABS(CORR.)
1	.0000		.0000
2	-.0054	-.0055	-.0048
3	-.0113	-.0059	-.0095
4	-.0174	-.0060	-.0146
5	-.0237	-.0062	-.0202
6	-.0298	-.0061	-.0254
7	-.0357	-.0059	-.0308
8	-.0418	-.0061	-.0354
9	-.0486	-.0067	-.0415
10	-.0542	-.0056	-.0462

CELL No.=6 ABS(START)= 1.197

CYCLE	A-A(S)	dA	ABS(CORR.)
1	.0000		.0000
2	-.0093	-.0094	-.0087
3	-.0215	-.0122	-.0197
4	-.0330	-.0114	-.0302
5	-.0446	-.0116	-.0411
6	-.0561	-.0114	-.0517
7	-.0669	-.0108	-.0620
8	-.0784	-.0114	-.0720
9	-.0899	-.0115	-.0829
10	-.1011	-.0111	-.0931

Fig. 4.5 Example of Operation in CPS KINETIC Mode

When the system is set to the CPS KINETIC mode, a display shown in Fig. 4.6 first appears on the CRT. Parameters are described in Table 4.2.

```
CPS KINETIC    PARAMETER CHANGE Y/N ?

1.λ= 800.0NM
2.ABS.RANGE=+2.00A
3.CELL N=6              CYCLE T=  15SEC
  LAG T=   5SEC         CYCLE N=10
4.FACTOR= 1.0000
5.START POINT(UPPER/LOWER)=UPPER
6.DATA PRINT            NO
7.REAGENT BLANK         NO
8.GAIN X10              NO
9.CELL BLANK

21:49  1/14 '85                    800.0NM   0.000A
```

Fig. 4.6 Display of Parameter Change in the CPS KINETIC mode

Table 4.2 Description of Parameters for the CPS KINETIC Mode

Parameter [Setting Range]	Description
1. λ [200 ~ 1100]	Represents measuring wavelength.
2. ABS. RANGE [0.01 ~ 5]	Represents the full scale of recording range. If YES is selected for GAIN X 10 (item 8), the range is reduced to 1/10.
3. CELL N [1 ~ 6] CYCLE T [3 X (CELL N − 1) ~ 300] CYCLE N [2 ~ 20] LAG T [0 ~ 3600]	Represent the number of cells, repetition time, the number of repetitions, and lag time, respectively. CYCLE T is to be set to 3 X (CELL N − 1) or longer in consideration of time required for cell displacement. CYCLE T and CYCLE N are to be selected so that the rate measuring time [= (CYCLE T) X (CYCLE N − 1)] is longer than 10 sec.
4. FACTOR [0.0001 ~ 9999.9] Zero and negative value is permissible	The factor is used for calculating the activity value from the rate of absorbance change.

Parameter (Setting Range)	Description
5. START POINT [UP, LOW]	To specify the starting point for the time change curve of absorbance. The curves for different cells start with slight shift from the top or bottom for UP or LOW, respectively.
6. DATA PRINT [YES, NO]	The area below the broken line in Fig. 4.5 is printed for YES, and not printed for NO.
7. REAGENT BLK [YES, NO]	To select setting or not setting the reagent blank. When YES is selected, the rate of absorbance change for Cell 1 is subtracted from those for Cells 2 ~ 6 to be corrected. The activity value is calculated by using the corrected value.
8. GAIN X 10 [YES, NO]	If YES is selected, the gain is multiplied by 10, and the setting range of ABS. RANGE becomes to [0.001 ~ 0.5]. Since Auto Zero is taken immediately before the first measurement for each cell, the first measurement value becomes automatically zero. After the measurement, the original value returns. If No if selected, the Auto Zero operation is not made.
9. CELL BLK	To be selected when auto zero is to be made for each cell.

Operating Procedures

Step	Operation, CRT Display	Key Sequence	Next Step
1	Select mode No. 9 (option mode)	MODE 9 ENTER	
2	OPERATION No.="1"? 1.SIPPER 2.EXT. REC. SPECTRUM 3.EXT. REC. TIME SCAN 4.CPS DATA PRINT 5.CPS KINETIC		
3	Select the CPS KINETIC mode	5 ENTER	
4	CPS KINETIC PARAMETER CHANGE Y/N ? 1.λ= 800.0NM 2.ABS.RANGE=+2.00A 3.CELL N=6 CYCLE T= 15SEC LAG T= 5SEC CYCLE N=10 4.FACTOR= 1.0000 5.START POINT(UPPER/LOWER)=UPPER 6.DATA PRINT NO 7.REAGENT BLANK NO 8.GAIN X10 NO 9.CELL BLANK		

Step	Operation, CRT Display	Key Sequence	Next Step
5	Set parameters	See Paragraph 4.2.1 in the Instruction Manual for the UV-160.	
6	Start operation	START/STOP	
7	End When pressing START/STOP key, the next measurement starts (to Step 6). When pressing RETURN key, the operation returns to Step 4. If RETURN key is pressed again, the operation returns to Step 2. Pressing MODE key here produces the basic mode menu display.		

4.3 Note on Temperature Control

The temperature detector is attached to the cell holder block, and thus the temperature indication differs somewhat from the actual cell temperature. The difference between the cell temperature and temperature indication increases with the difference between the room temperature and preset desired temperature. The following figures show these differences between the cell temperature and the indicated temperature. The following show only specific examples, and they are not the guaranteed data. Additionally, these measurements are made with the cells filled with water.

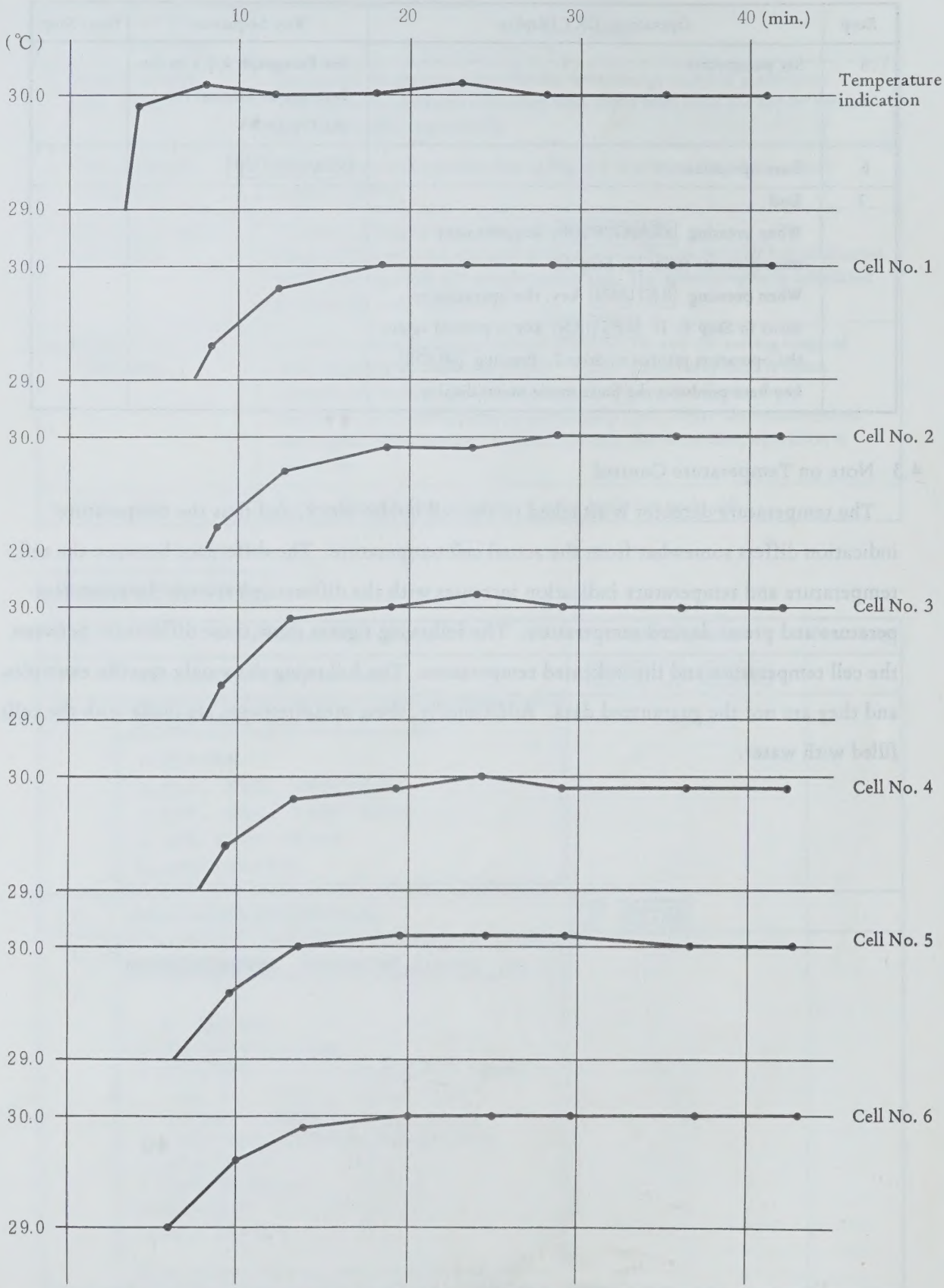


Fig. 4.7 Measured Example of Cell Temperatures (room temperature 25°C, preset temperature 30°C)

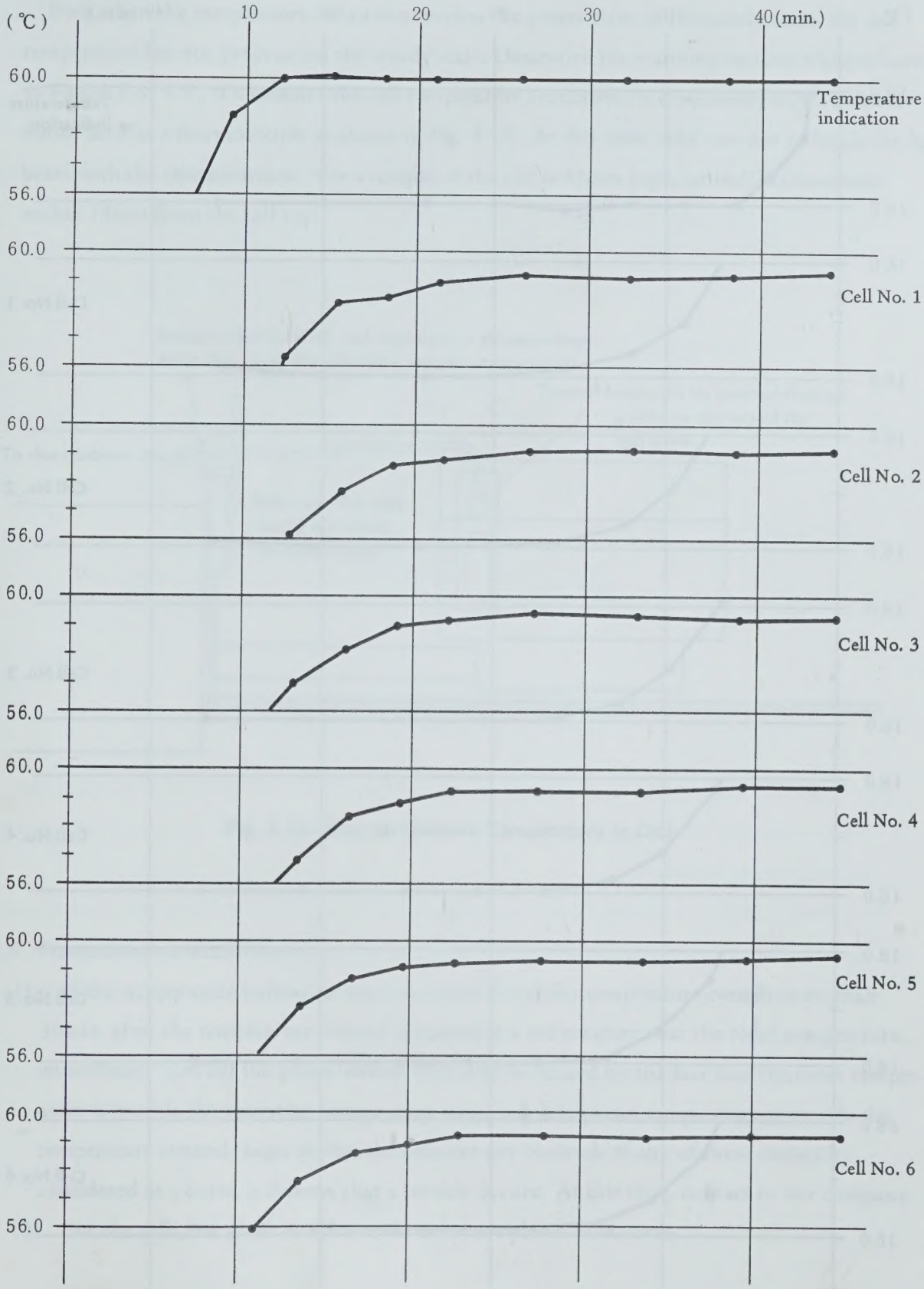


Fig. 4.8 Measured Example of Cell Temperatures (room temperature 25° C, preset temperature 60° C)

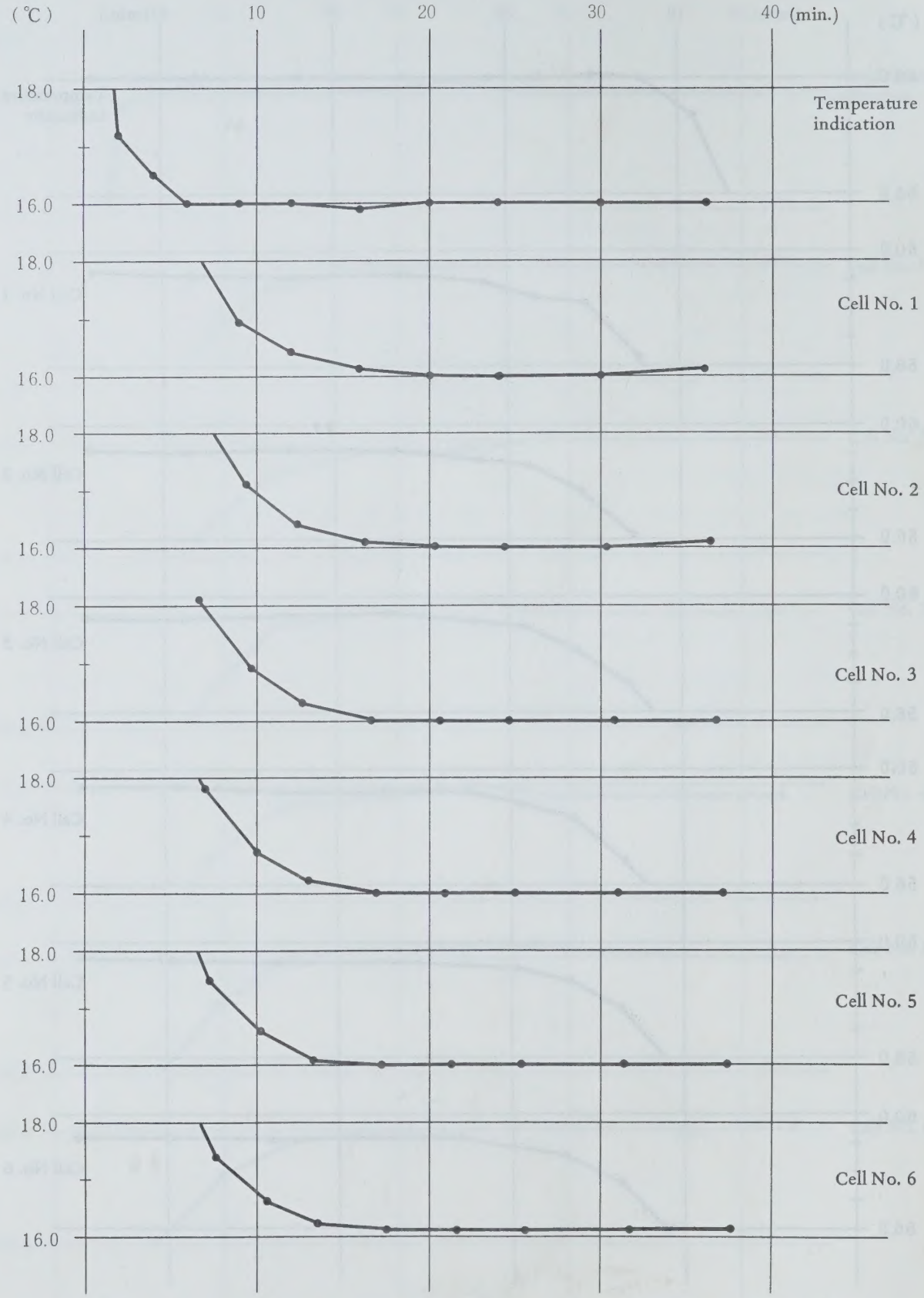


Fig. 4.9 Measured Example of Cell Temperatures (room temperature 25° C, preset temperature 16° C)

Even when the temperature indication reaches the preset value in the steady state, the cell temperature has not yet reached the steady state. Determine the warming-up time while referring to Figs. 4.7 to 4.9 . To measure the cell temperature accurately, it is necessary to set a thermo-sensor such as a thermocouple as shown in Fig. 4.10. At this time, take care not to block the light beam with the thermo-sensor. For example, if the cell is 45mm high, set the thermo-sensor within 18mm from the cell top.

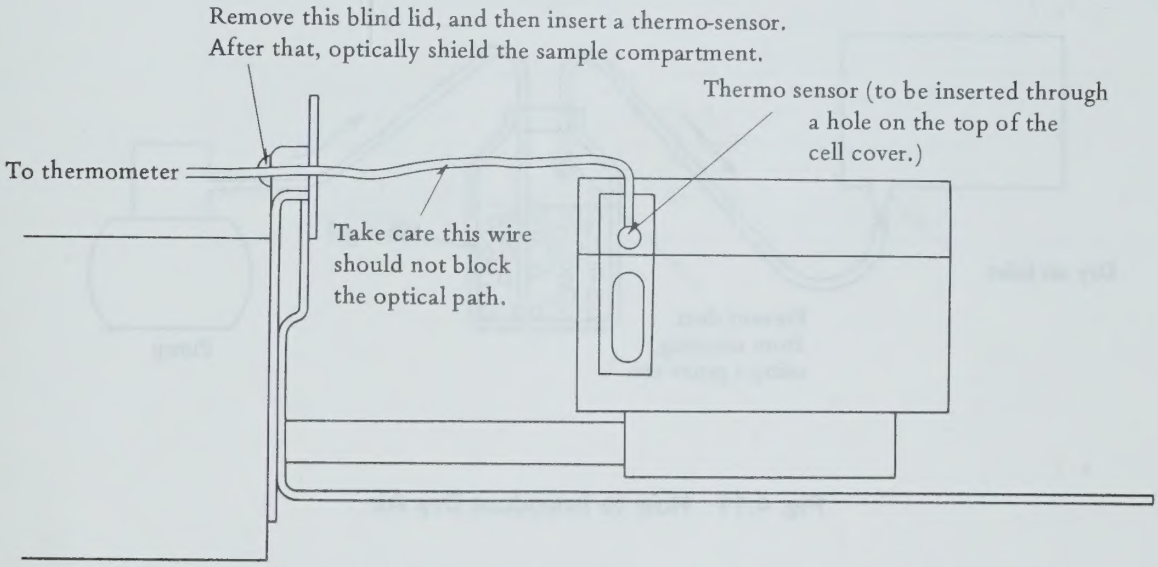


Fig. 4.10 How to Measure Temperature in Cell

4.4 Precautions on Measurement

(1) If the temperature indication does not reach the preset temperature even in more than 30min. after the temperature control is started at a temperature near the room temperature, immediately turn off the power switch. This may be caused by the fact that the room temperature is outside the operating temperature range, that the preset temperature is outside the temperature control range, or that the cells are not covered. If any of them cannot be considered as a cause, it follows that a trouble occurs. At this time, contact to our company.

(2) For the cells, use glass- or silica-made ones, not plastic-made ones.

(3) If dews are produced on the cells at a temperatue below the room temperature, introduce dry air through the dry air inlet, as shown in Fig. 4.11. In this case, use a pump of flow rate 13 ~ 15ℓ/min with max. pressure 1.0 kg/cm². The dry air inlet has two outer diameters; 8mm and 12mm. Therefore, to introduce the dry air, use the tube which has the inner diameter of 1 ~ 2 mm less than the inlet outer diameters. Additionally, note that the warming-up time may be elongated when a dry air is introduced.

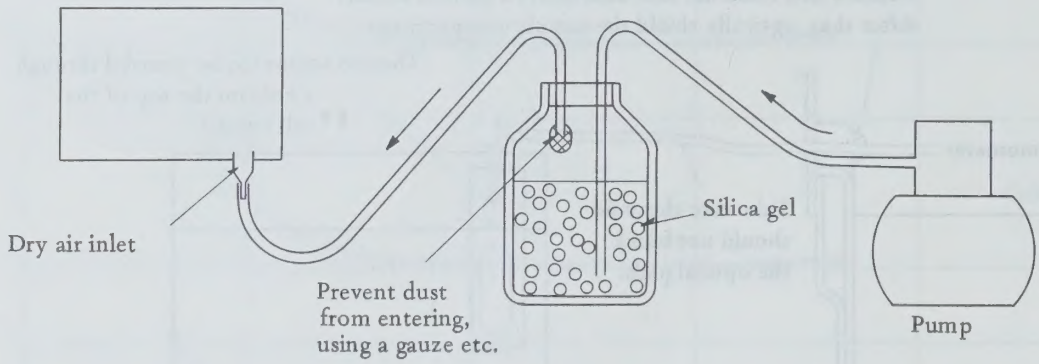


Fig. 4.11 How to Introduce Dry Air

(4) Take care not to place an obstacle near the wire net in front of the sample compartment unit, or the heat exchange should become worse due to obstructed air flow, thus deteriorating instrument performance.

(5) In the position of cell No. 6, the cell cover cannot be removed, and thus avoid this position for sample exchange. Additionally, don't forget to restore the cell cover after exchanging samples; otherwise, the heat isolating effect becomes worse, thus deteriorating the instrument performance.

(6) In using narrow cells such as micro cells or flow cells with the UV-240/250, set the spectral slit width to less than 2nm. Additionally, don't use a cell of less than 4mm width. With the MPS-2000, don't use narrow cells. Only the rectangular 10mm cells are recommended.

5. Maintenance

(1) The cell holder is covered with a heat insulating material with good chemical resistance. However, if a sample is spilt on the cell holder, wipe it with dry cloth, and then dry it sufficiently.

(2) The variable resistors in the CPS controller cover have been adjusted at the factory for the linearity of the temperature sensor. Therefore, don't touch these resistors; oterhwise, an error in the temperature indication occurs.

(3) Don't remove the outer cover unnecessarily; because, a high voltage is applied to the terminal on the CPS controller inner rear panel with a danger of electrical shock.

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